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A NEW METHOD OF REGULATING ARC, OR CONSTANT CURRENT, DYNAMOS.

BY

F. Tischendörfer

THE writer, in designing the method of regulation described below, set about to fulfill the two following conditions: 1. The current in the armature must be constant, while the ampere turns of the field magnets may vary. The brushes are to remain fixed in position without causing sparking, under all conditions of load in the working circuit.

These conditions have been met in a system of regulation whereby the area of the inducing magnetic field is made variable, increasing the area of the magnetic fields in the direction of the rotation of the armature, by an increase of the load in the working circuit, and by decreasing this area in the reverse direction upon a decrease in the load.

The accompanying engraving, Fig. 1, shows the dynamo, one designed for 12 arc-lamps at 12 amperes, and Fig. 2 shows the automatic regulator employed.

The operation of the machine will be clearly understood from the diagram, Fig. 3. Here L represents the line circuit, connected at one end to one of the commutator-brushes, B^1, and including a series of arc-lamps, the return circuit being connected through the magnet M^3 and field-magnets M^2 of a regulating electric motor M', and ultimately through the regulator G, and one of the circuits

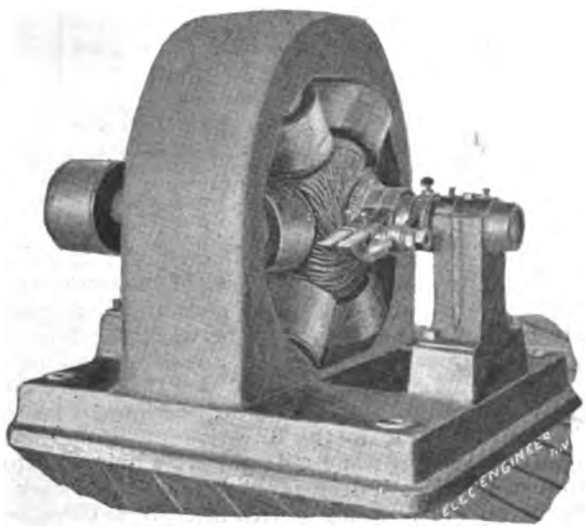


FIG. 1.—TISCHENDOERFER ARC DYNAMO.

w to w^{12} and field-magnets N to N^2 and S to S^2 to the other commutator-brush B.

The field-magnets are constructed with re-entrant poles N N' N^2 S S' S^2. Each of the field-magnet coils is divided into sections or layers connected in sequence at the points 1, 2, 3, &c., to 12, with branch conductors w to w^{12}, running to insulated conducting-segments C to C^{12}, arranged in circular order around a shaft D, which carries also a geared regulating-wheel J, meshing with a worm W on the armature-shaft of the regulating-motor M', the commutator T of which is connected on one side by stationary brushes K through a conductor e' with one of the coils of the field-magnet coil N at a point t'.

K' represents a pair of movable commutator-brushes carried by a pivoted armature-lever A', provided with an adjusting-spring s, this armature being located in the mag-

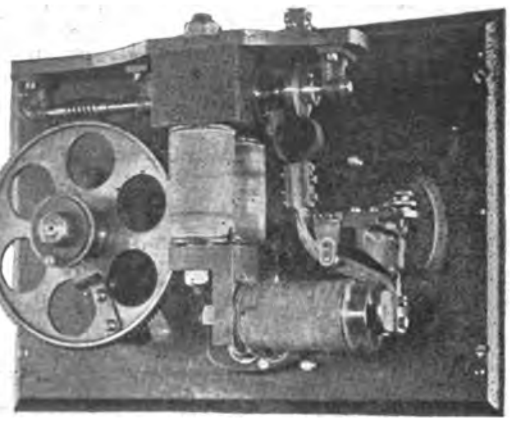


FIG. 2.—TISCHENDOERFER AUTOMATIC REGULATOR.

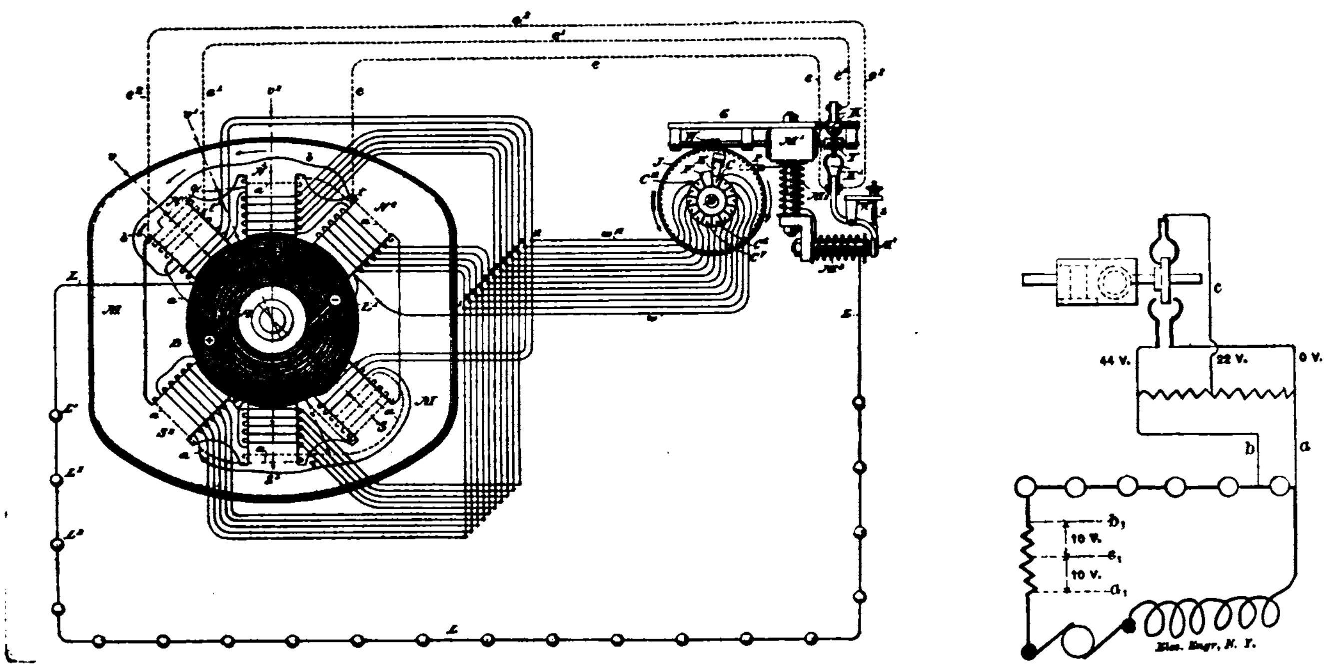
netic fields of the regulating-magnets M^3, the coils of which are connected directly to the exterior or working circuit and in series with the field-coils M^2 of the regulating motor M'. These two brushes K', which are insulated from each other, are connected, respectively, by wires e and e^2 with the coils of the field-magnets N^2 and N at points t and t^2, the former being connected to the field-coil N at the point of greatest potential of the machine—that is to say, near the plus commutator-brush B—while the latter is connected to the field-coil N^2 at a point t of much lower potential, the conductor e' being connected to the coil N at a point t' of intermediate potential, as shown.

The operation of the apparatus is as follows: Suppose the lamps to be all in circuit and the machine to be working with a full load. Under this condition of affairs the retractile spring s of the armature A' is so adjusted that the brushes K' are held out of contact with the ends of the commutator-strips of the commutator T, and the motor, therefore, is inert. The current then flowing magnetizes all of the field-magnets N to N^2 to the necessary point of saturation, and S to S^2 to a similar point of saturation, and circuit may be traced as follows, the circuit being in parallel from the plus commutator-brush through the layers of the north and south field-magnet poles respectively. Passing by the dotted lines a from the brush B to field-magnets N and S around the several layers of dotted windings, thence to field-magnets N' and S', (shown each as one layer of dotted winding,) thence to field-magnets N^2 and S^2, (shown each as one layer of dotted winding,) and thence by the full-line conductors b to the first field-magnets N and S through two sections, giving the same polarities as before, thence to field-magnets N' and S' through five sections, giving the same polarities as before; thence to field-magnets N^2 and S^2 through five sections, giving the same polarities as before, the conductors being connected ultimately to the wires w to w^{12}, running to the conducting-segments c to c^{12} on the regulator G. As long as this state of affairs continues the field-magnets will be energized to the desired point of saturation.

Suppose, now, one or more of the lamps are removed from the circuit, or short-circuited. The armature A' is immediately drawn forward by the increase of current, thereby causing the left-hand brush K' to come into contact with the commutator T, carried by the armature of the motor M', thereby connecting the brush with the field-magnet circuit at the point t. Immediately, therefore, a derived circuit is formed from the field-magnets through the conductors e and e', the current passing from the point t' of higher to the point t of lower potential through the armature of motor M' in such direction as to impart to the gear-wheel J, through the worm W, a motion in the direction of the tailless arrow, shown on the right of the wheel J, causing the sliding contact E to pass from the segment C to the succeeding segment C', whereby the first layer or section of the field-magnet N^2 is cut out of circuit, and the corresponding section of the south field-magnet S^2 is similarly cut out of circuit, thereby diminishing the magnetic effect of the field-magnets upon the armature, without, however, decreasing or in any manner affecting the magnetic effect of the remaining field-magnets N N' and S S'. As soon, therefore, as this decrease in the magnetic condition of the field-magnets N^2 and S^2 is effected, a decrease of the current on the line will result and the armature A' will assume its normal position, which it will maintain for a given quantity of current in neutral position, as shown in the diagram.

As this action is repeated, therefore, and lamps are successively removed from the circuit successive sections of the field-magnet coils N^2 and S^2 will be cut out, until finally all of the sections indicated in heavy lines will be removed from the circuit, and so on in succession the various sections of the field-coils N' S' will be continuously removed until all of the sections indicated by heavy lines have been cut out. In like manner, also, the two successive sections in the field-coils N and S will be removed when the E. M. F. required upon the line is a minimum. It will be noticed, however, that those coils indicated upon the field-magnets in dotted lines are never removed from the circuit, and that this dotted-line circuit is made to include a greater proportion of the field-coils in the magnets N and S and only one section in each of the coils N' and S' and N S^2. This arrangement of coils is designed for the purpose of always leaving the machine in such a condition that it will act upon the self-exciting principle, no matter what may be the resistance or condition of the exterior circuit, and also with diminished effect upon the field-cores N' S' and N^2 S^2 under all conditions of resistance in the exterior circuit, it being necessary to always maintain a certain proportion of north magnetism in the cores N' N^2 and south magnetism in the cores S' S^2 in order to prevent a magnetic short-circuit through the same inner-end field-poles and the armature.

With this method of regulation it is possible to maintain the commutator-brushes always in a fixed position and to avoid sparking under all conditions of load, inasmuch as no change is made in what is known as the "magnetic lead," by virtue of the fact that the magnetic lines of force are always maintained at the proper degree in the various field-cores in proportion to the demands of the exterior circuit. In other words, when the machine is working with a full load the resultant of all of the magnetic lines of force will be through the centre of the field magnet cores N' S', as shown by the line of arrows v^2.



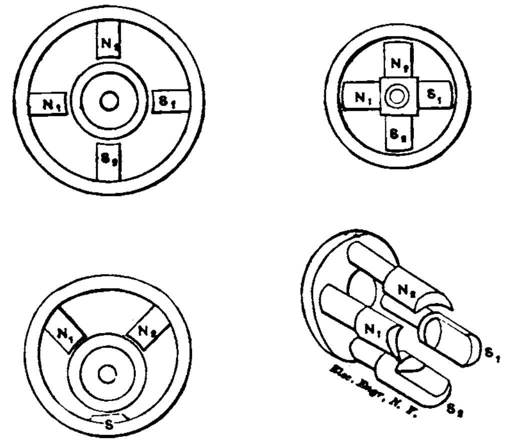
FIGS. 3 AND 4.—TISCHENDOERFER'S METHOD OF CONSTANT CURRENT REGULATION.

When the magnetism of the field-cores N^2 S^2 is reduced to a minimum by the cutting out of all of the sections of its winding, the resultant effect of the lines of force remaining will be felt at a point midway between the field-cores N N' and S S', as shown by the arrows v' and in like manner when the magnetic effect of the two sets of coils N' S' N^2 S^2 is removed, the resultant of the lines of force remaining will be found in the direction of the arrows v through the field-cores N and S. It will be readily understood, therefore, that for each decrease in the load in the working-circuit the lines of force are shifted in a reverse direction to the direction of rotation of the armature, and vice versa, on increasing the load in the circuit.

In the diagram, Fig. 3, the magnet coils N N^1 and N^2 are connected in parallel to the magnet coils S S^1 and S^2, but it is desirable to connect all coils N and S in series. This series connection is made in the dynamo shown in Fig. 1 in such a manner that first two layers of N^2, then two layers of S^2 and so on are cut out. The tests of the dynamo also shows that the remaining layers in the coils S^1 and S^2 and N^1 and N^2 which are shown in Fig. 3 by the dotted lines and which were employed to avoid magnetic shunt-circuits between like poles, and the adjoining part of the armature core, are not necessary.

The tests demonstrated the remarkable fact that all layers of the coils N^1 and N^2 and S^1 and S^2 can be cut out entirely without any signs of sparking at the brushes, even when the coils N and S alone are in circuit, these being necessary to operate only one lamp. The small dynamo constructed gives 700 volts and 12 amperes at 1350 revolutions per minute, and no sparks are visible with the brushes fixed, although the voltage varies from 700 down to 60.

It is not necessary in a large dynamo to have as many



FIGS. 5, 6, 7 AND 8.

magnet coils or branch of conductors as there are lamps in the working circuit, because a not too large variation of current will be equalized through the reaction of the armature on the magnetic field.

The small armature of the motor of the automatic regulator is in shunt to the main circuit in the regulator shown in Fig. 2, but it can also be operated as shown in Fig. 4, in which a high resistance is connected in parallel to the first lamp, and from this resistance there are taken off the three potentials a, b, and c (0, 22 and 44 $v.$); or there can be placed in the main circuit before it reaches the lamps a small resistance of about 2 ohms, and the armature brushes connected with the three potential a_1 b_1 c_1.

The new method of regulation by diminishing or increasing the induction area can be carried out with more or fewer re-entrant poles. A few examples of such cases are shown in Figs. 5, 6, 7, and 8.

It will also be evident this system of regulation can be applied to constant potential dynamos and motors, and also to constant current motors.

THE DETERMINATION OF SPECIFIC HEATS BY THE ELECTRIC CURRENT.

A METHOD of determining specific heats by the electric current was published by Prof. J. Pfaundler in 1869. It depended on Joule's law, and was one in which the same current develops quantities of heat, in coils of wire arranged in series. This method has hitherto found but few applications from the circumstance that it only applies to non-conducting liquids. According to an article in the *Wiener Berichte*, Prof. Pfaundler has got rid of this drawback by substituting for the coils of wire spiral glass tubes filled with mercury. He has also given the method far greater accuracy and certainty by inserting three mercury resistances in the branches of a Wheatstone bridge, by which it is possible to control and keep constant the ratio of the resistances during the passage of the heating-current. Small variations in resistance are compensated by introducing glass threads in the straight ends of the tubes which contained the mercury. In other cases these changes are measured by displacing the contact-key, and in this way the result is corrected. The comparative measurement of the rise of temperature is made more delicate by means of a thermopile.

NEW METHOD OF REPORTING GAMES AND RACES.

BY

PROBABLY no one thing tends more to popularize recurring events, such as amusements of all kinds, than the wide dissemination of detail reports of such amusements by the newspapers, telegraph ticker, etc., and no less is this the case with sporting events than it is with amusements in general.

Undoubtedly the more ornamental, attractive, and pleasing the instruments placed before the public eye, provided the methods employed are reliable, the wider becomes the field of its operation, and to the extent of this field of operation does any particular sport become advertised, or, what amounts to the same thing, substantially in this case, popularized.

An apparent demand exists for some means to supply the public resorts with just the news that they want, omitting the general financial and stock market reports, which they do not want and will not pay for at such rentals as will enable the ticker companies to profitably supply them, and for this statement there is no better proof than the

FIG. 1.—RACE DIAL, MOTT SYSTEM.

fact that only one saloon or public resort in a hundred of all grades is supplied to-day with tickers in New York.

To meet this demand inventors have endeavored for years to improve the present stock ticker; to simplify it, cheapen it, get rid of its delicate adjustment, operate it over one-line wire instead of two and three lines, force its working over long distances, exceeding at least the present limit of about 15 miles, and other minor disabilities. But so far there has been no improvement to overcome these defects, nor is there likely to be on the lines of the present stock ticker, and the perversion of its legitimate field as an instrument of commerce to the reporting of athletic sports does not come up to the requirements of the athletic community nor supply the demands of this market at popular or unpopular prices.

The conservative estimate that $5,000,000 changed hands last season in the racing of horses, and that $2,000,000 does not cover the transactions incident to the game of baseball,

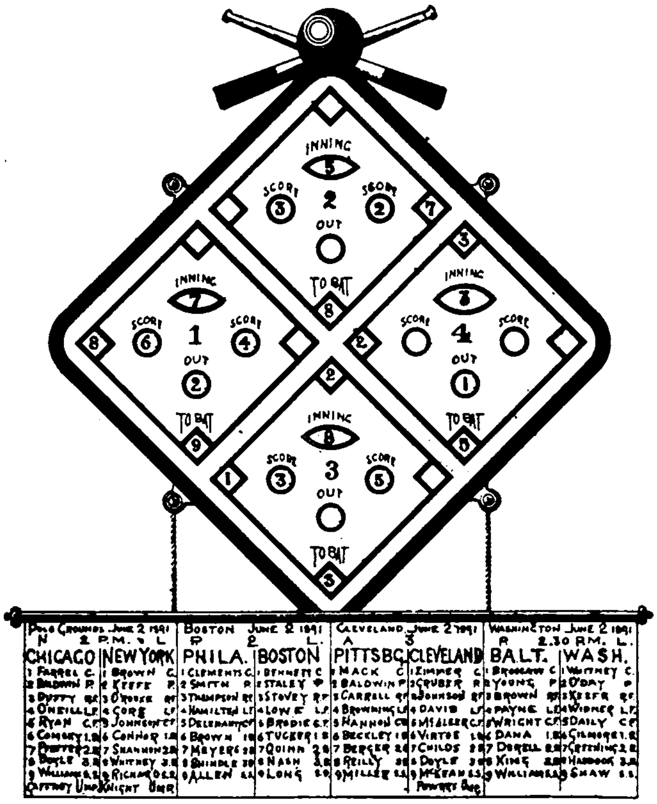


FIG. 2.—BASEBALL DIAL, MOTT SYSTEM.

goes to show the commercial status these sports are taking with the American public, and emphasizes the demand for a simple bulletin visible to all the persons in a room, indicating the various points of a game concurrently with the play, as plainly as a clock indicates the time of day. Numerically considered, the market for such an instrument is as much greater than the market for the stock tickers in its legitimate sphere, as the public resorts in a city exceed in number the brokers' offices.

Such an electric system of visually indicating the concurrent report of a game or race I have devised and they are illustrated in the accompanying engravings. Fig. 1 shows a race dial reporting the Brooklyn Jockey Club races at Gravesend track, May 30 last. The entries, purses, length of race, character, whether sweepstake or handicap, best record, weights, ages, jockeys, etc., is placed on the entry slip and held by a clip in juxtaposition to the bulletin. The face of the dial, which is electrically operated, shows the field in each race, the scratches, if any, the winner, second and third, and the time. For instance, the third race was one mile, purse $2,500. Winner, Longfellow; second, Airplant; third, Spinalong; time 1.18¼. The fifth race is about to start. Guilty and Billet Doux are scratched.

Fig. 2 shows a dial reporting four games of baseball simultaneously, or in any order, illustrating the main features of the game in either case. The Chicago and New York teams, of the National League, are playing at the Polo Grounds, N. Y., June 2, 1891, at 2 p. m. The score is 6 to 4, in favor of the former; the 7th inning is being played; two are out; Williamson at the bat, Doyle on 3d base. Philadelphia and Boston at Boston, same date, 2 o'clock; score, 3 to 5 in favor of Boston; 5th inning. Pittsburgh and Cleveland at Cleveland, score 3 to 5, 8th inning. Baltimore and Washington at latter place same date, 2.30 p. m., score 0; 3d inning; one out; Young on 3d base; Wright to bat; Brown on 2d base.

Fig. 3 shows the electrical organization, which is so plain that no detail description will be necessary. Its main features are the segment circle or selector, with trailing lever, the local and transmitting battery, the latter being thrown on the line in positive and negative impulses by the keys *k' k* respectively. The problem, simply stated, is to enable an operator to select any one of any number of magnets at a distant point or a number of distant points, and when so selected to cause the one selected to operate. The instrument A, which is used for relaying and repeating in this case, controls two separate and independent locals from the battery B', the one selecting the magnet and the other energizing the magnet selected. The number of local magnets is determined by the number of features to be shown on the face of the dial and is limited by the number of segments or in the selector. The addition of more magnets being a mere duplication of parts.

Because of its simplicity and few working parts this instrument costs less than one-fifth of the cost of tickers; many instruments may be operated over single-line circuits to any distance, as the system may be relayed and repeated ad infinitum; it requires no delicate adjustments, no winding or supplying with ink or tape. All indications on the face of the dials are brought to blank spaces by the operator after the day's events have been reported, or in case a mistake has been made by the operator. The expense of operation is minimized, as no receiving operator is required, as with telegraphy.

A relay may be interpolated in the main line for inter-

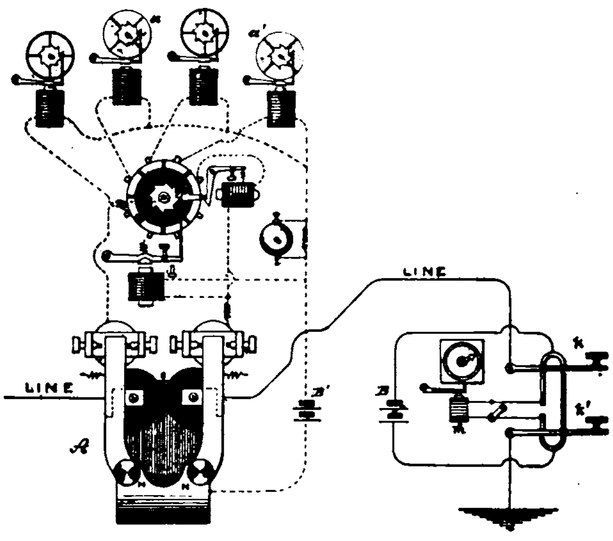


FIG. 3.—DIAGRAM OF THE MOTT SYSTEM.

mediate working of 20 to 25 dials in locals so arranged that *no* resistance nor even a disturbing influence is apparent on the main line. Unlike the tickers, it may be operated from the grounds of play or race track, or, like the ticker, locally. It can be easily operated by a transmitter which may be carried in the pocket, requiring no skill, but good judgment on the part of the operator. A feature of no little consequence is the fact that all signals are unintelligible if the line is surreptitiously tapped.

ELECTRICAL ENGINEERS.

FRANCIS W. JONES.

SOME time or other it will be worth the while of the historian to investigate the facts in connection with the Loyalist emigration from this country at the time of the Revolution, to British North America and the West Indies, and then the subsequent inflow of the descendants of those political exiles as new settlers. There are to-day a large number of people in this country who are regarded as Canadians or West Indians, when in truth they are more distinctively American than any whose fathers came here after 1776; and they are not a little proud of a fact that lies at the bottom of much of the tendency to closer political relationship between the various portions of this continent.

It was of such interesting Loyalist ancestry, exiled from New England, that Francis Wiley Jones was born, at Weymouth, Nova Scotia, in the old family homestead, one of the first in those primeval forests. At Weymouth, Mr. Jones spent his youth, and in 1859, when only thirteen years of age, he entered the Post Office, at Kentville, N. S., as a clerk. There, without any help or advice, he learned telegraphy, and in about three months began telegraph work also. He continued in this dual capacity, varying the monotony by issuing marriage licenses and recording vital statistics, until 1867. It may be mentioned that Mr. J. F. Morrison, of Baltimore, the first president of the National Electric Light Association, was an operator at Aylesford, on the same line. Mr. Jones then removed to St. John, New Brunswick, where he accepted a position as operator under Mr. R. T. Clinch, the superintendent of the Western Union Telegraph Co. He was soon given full care of the batteries in addition. The office was then the repeater station for the Atlantic cables, just put in operation, and was one of the most important of the company, besides being a nursery of talent from which came such well-known men as J. Ranney, B. S. Black, E. T. Barberie and the two Dorans. During 1868–9 severe electric storms occurred, stopping many of the circuits. On several occasions the batteries were disconnected and the wires were worked entirely by auroral currents. At Mr. Jones' suggestion, two wires between St. John and Plaister Cove, the eastern repeater point, and two between St. John and Boston, the western repeater point, were looped into metallic circuits, and the St. John-Milliken repeater spanned the two loops in such a way as to eliminate all earth connections. Signals were immediately exchanged free from atmospheric disturbances. A similar plan was afterwards adopted by Mr. Geo. B. Prescott between New York and Boston.

Mr. Jones thinks that St. John was perhaps the first American city that saw a public exhibition of the electric light. About this time, the city being visited by a member of the royal family, he connected two battery carbons to a Grove battery of 80 cells, fed them by hand, and from the Western Union windows made a fitful but very brilliant display to an immense crowd of puzzled and dazzled sight-seers on Prince William street.

Thinking that the United States would afford him more elbow-room in the electrical field, and being full of youthful energy, Mr. Jones left St. John for Chicago, arrived there in May, 1872, and was at once enrolled on the night force. He now saw a galvanometer and a Stearns duplex for the first time, and at once made their intimate acquaintance. In 1873 he was appointed Sunday manager, and was entrusted with onerous work in moving the office to its present position on La Salle street. In 1875 the American Electrical Society was organized in Chicago, and upon Mr. Jones as its corresponding secretary and librarian fell the work of issuing, with Mr. William Henry Smith, the valuable and now rare transactions of that body. In No. 3, vol. 2, is an able discussion by him on the nature, effects, and telegraphic remedies for electric storms.

In September, 1874, Mr. Edison put the quadruplex in operation on the Wheatstone Bridge principle between New York and Boston. As arranged, the quad was then barely successful on short circuits and not much better than a duplex on long circuits. In August, 1875, Mr. Jones reduced it to the differential form between Chicago and Buffalo, with repeaters at Detroit, with such marked benefit that the latter method was adopted throughout the Western division, and two years after throughout the country; and the New York-Chicago quad circuits were for the first time put into use for business, and with but one or two slight changes, the quadruplex as used by the Western Union to-day is substantially as modified by Mr. Jones in 1875. The same year Mr. Jones was appointed assistant manager of the Chicago office with care of the operating department and the circuits.

In 1880, on the resignation of Mr. G. B. Prescott, as electrician of the Western Union Telegraph Co., the new position of general circuit manager was created for Mr. Jones, under Mr. John Van Horne, vice-president, Mr. George A. Hamilton becoming electrician to the company. Mr. Jones continued as general circuit manager in New York until the spring of 1882 when he resigned to get rest and recover his health. He now became general manager of the Union Electric Mfg. Co., where he remained for two years, acquiring a valuable experience in processes of electrical manufacture. In 1884, however, his old tastes led him back into the telegraphic field, and he became electrician of the Bankers' and Merchants' Telegraph Co. For this corporation, then in its heyday, he arranged a duplex with an induction coil to obviate the static troubles, and it is said to be the only one that can successfully compete with the Stearns condenser duplex on long lines.

When the financial crisis of 1884 forced the B. & M. into the hands of a receiver, Mr. Jones was asked to assume the general management of a seemingly hopeless wreck, falling daily into deeper debt. Mr. Jones took up this cheerful task, and in 1885 Mr. A. B. Chandler, president of the Postal Telegraph Co., came to his assistance with mental and financial help of the most encouraging nature. Mr. Jones gladly resigned in Mr. Chandler's favor, and became the assistant general manager and electrician of both concerns. Since that time affairs have assumed a wonderfully different aspect, and as the result of their conjoint labors, the Postal has the reputation to-day of being one of the best-run telegraph companies this country has ever seen. With Mr. Chandler's approval, the New York, Chicago, Boston and Pittsburgh Postal offices have been entirely equipped with dynamos for supplying current to all their wires, and the New York office is the first in the world where dynamo current was used for both the main and the local circuits. Mr. Jones has displayed much inventive skill and ingenuity in this work, and the Postal methods, which have been patented, yield results that are most satisfactory.

Since 1877 Mr. Jones has been a citizen of the United States. He is a life member of the New York Press Club, the New York Telegraph Club, and the American Institute of Electrical Engineers. Of the latter body he is a charter member and was one of its first officers. Mr. Jones, on his removal to New York from Chicago, proposed the formation of the New York Electrical Society—now the oldest electrical body of its class in the country—and was elected its first president. Mr. Jones has also taken an active interest in the welfare of operators and was largely instrumental in the starting of the Electric Building, Loan and Savings Association, formed by Postal Telegraph employees, and is vice-president of the organization.

THE WILLSON ELECTRIC ALUMINUM PROCESS.

In the production of aluminum and its alloys, or other metals of equally refractory character, by means of the electric current, the ore is fused and decomposed, and the oxygen thus liberated attacks the containing crucible and the electrodes, which are usually made of carbon, by means

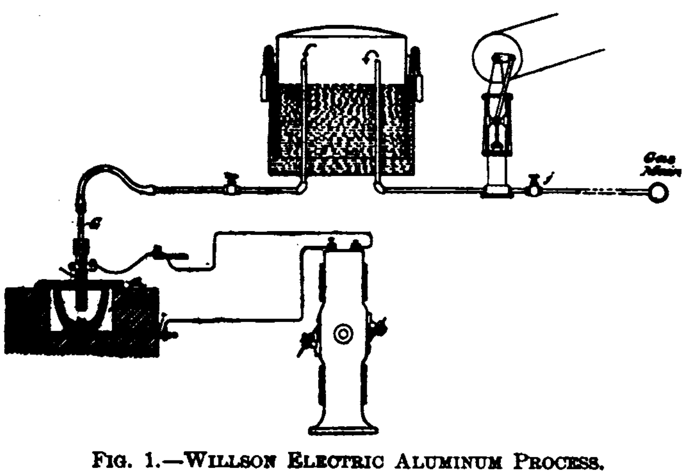


FIG. 1.—WILLSON ELECTRIC ALUMINUM PROCESS.

of which the current is introduced and rapidly wastes them away. The material of the electrodes and crucible is thus made to act as a reducing agent, and the process of electric smelting is rendered expensive.

In order to avoid this loss, Mr. Thomas L. Willson, of Brooklyn, the electrical engineer of the Willson Aluminum Co., of this city, has devised a method of introducing a deoxidizing agent in the form of a hydrocarbon gas, so that it shall be interposed between the liberated oxygen, and the surfaces of the crucible and electrodes.

In the accompanying engravings, Fig. 1 shows a diagrammatic elevation of the general apparatus, and Fig. 2 a detail sectional view of the furnace and electrodes employed in carrying out the process.

As will be seen, A is a hearth of brick-work having an opening within which the crucible is set resting upon a carbon plate built into the hearth, and forming the bottom of the opening. The positive and negative terminals of the dynamo are connected, respectively, with the carbon plate, and the carbon pencil E. The connection with the

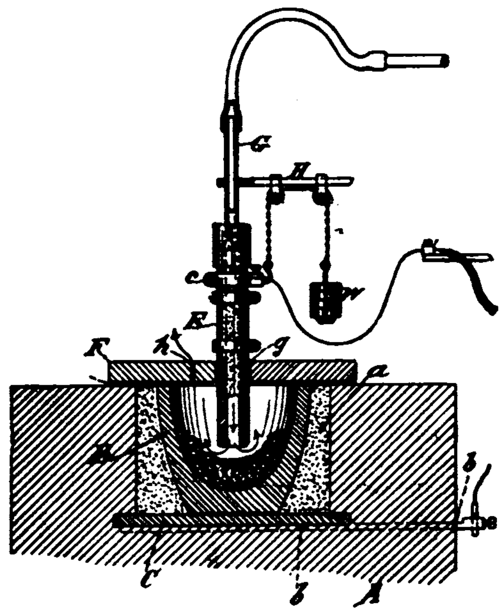


FIG. 2.—WILLSON ELECTRIC ALUMINUM PROCESS.

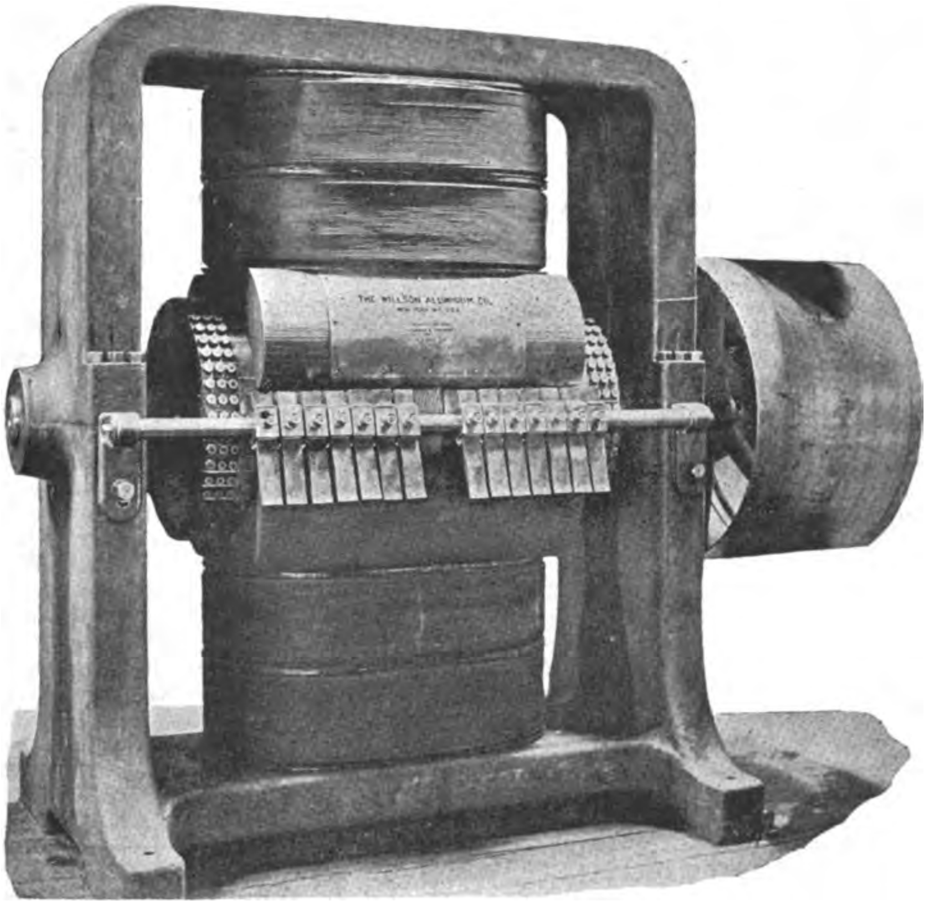
carbon plate is made through the medium of the metal bar *b*.

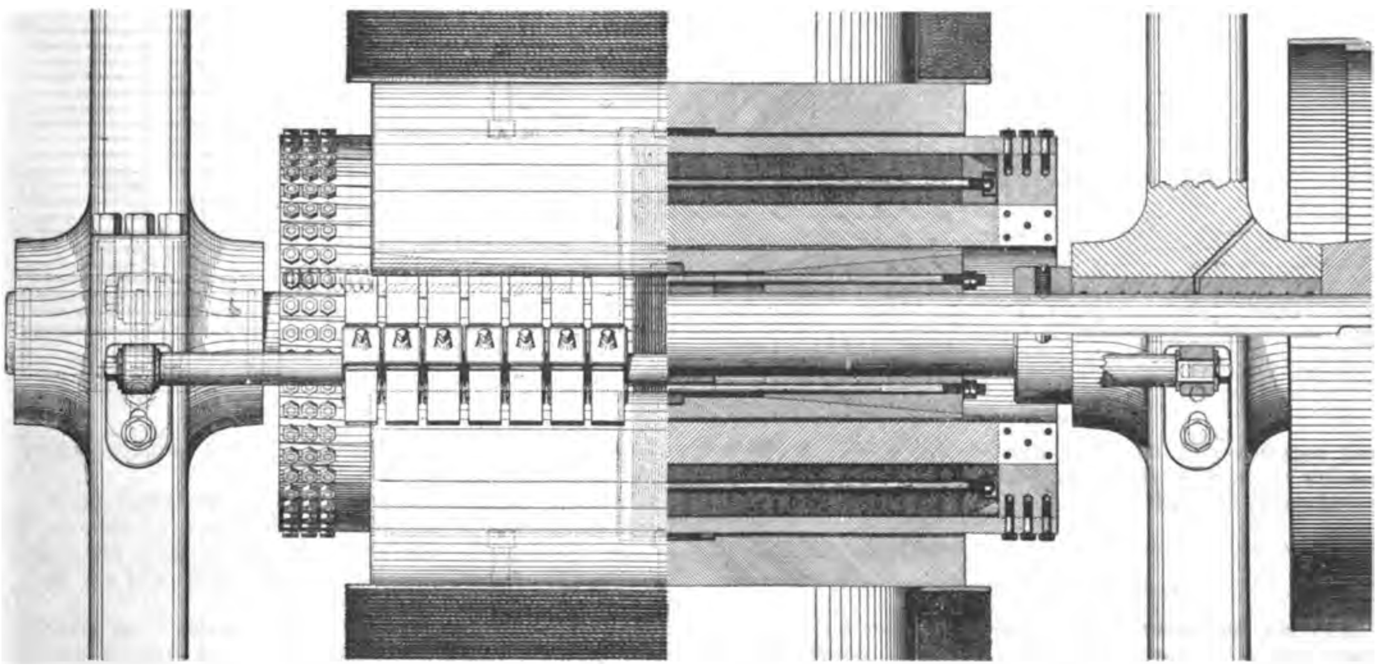
The carbon electrode E is made tubular, as shown in Fig. 2, the duct through it constituting a gas-passage. The upper end of the carbon-rod has united to it an iron pipe G, which extends upward in line with the corbon-rod, and is connected to the supply of gas. A gas holder, shown in Fig. 1, is provided to equalize the pressure of the gas.

The operation will now be readily understood. In the bottom of the crucible is placed a quantity of broken copper, and, on top of this a layer of alumina in the form of a nearly pure corundum.

The cover is then placed over the crucible and luted down, and the carbon pencil thrust through it and pressed down through the layer of corundum until its tip touches the copper. After the current has been started by bringing the carbon pencil in contact with the copper, the carbon pencil is lifted slightly to strike the arc, and as the copper fuses it is lifted still higher until the maximum arc is formed. This arc is then maintained stationary. At the same time the gas is turned on, and during the operation the pump is kept running at sufficient speed to supply the desired quantity of gas at the proper pressure. This pressure should be sufficient to overcome any pressure existing in the furnace, and to cause a slight blowing out of the gaseous products of combustion through the vent.

The heat of the arc first fuses the copper and sets it into ebullition, partially vaporizing it. As the heat becomes more intense the alumina is also fused, and is decomposed, its oxygen being set free and immediately combining with the hydrocarbon gas pumped in and forming carbonic acid, carbonic oxide, and steam, which escape through the vent. The aluminum, which is freed from its combination with oxygen, at once combines with the copper, forming an aluminum bronze. Throughout the operation the copper is vaporized by the intense heat and the copper vapors circulate within the crucible, becoming condensed against the comparatively cool sides and streaming down as liquid copper through the mass of corundum, whereby a circulation is created through the latter, and as rapidly as the corundum is fused and its oxygen driven off, the copper combines with the aluminum. The operation consumes from fifteen minutes to two hours, depending upon the character of the corundum, the proportions of the ingredients, and the strength of the current.





Figs. 3 and 4.—The Willson 750,000 Watt Generator and Armature.

When the corundum has been wholly fused and melted down, and its oxygen eliminated, there remains in the crucible a bath of molten aluminum bronze, which is poured or tapped out of the crucible. A special type of dynamo to be used in connection with this process has been designed and built by Mr. Willson, and is shown in the engraving, Fig. 3. This machine weighs 25,442 lbs. It has a 24-inch Gramme armature, weighing 6,163 lbs., mounted upon a 5-inch hammered steel shaft. The shaft bearings are of composition brass, 15 inches long. There are over 11,000 pounds of cast iron in the frame of the machine, and 7,000 pounds of forged iron in the pole pieces, etc.; and altogether it contains 7,456 pounds of copper in the fields and armature. The capacity of the dynamo is 750,000 watts at 530 revolutions per minute, and it is designed to run at 50 volts.

One of the special features of this machine is the arrangement of the brushes, which, as will be noted, are placed directly against the outer surface of the armature bars; the commutator as such is thus done away with. The armature bars, which are $1\frac{1}{2}$ sq. in. in section, are thoroughly insulated with asbestos and with mica where the brushes bear, and are practically indestructible. One armature of this type, after four years of constant operation, shows not more than $\frac{1}{32}$ inch reduction of size. As will be seen by reference to Fig. 4, no spiders are used, and the shaft is gripped by an expansion hub, the friction being automatically taken up by means of a constant spring pressure. Tests of the machine have shown it to run remarkably cool and to possess a high efficiency.

The machine illustrated has been constructed by Mr. Willson for the Willson Aluminum Co., and will shortly be put in operation at Leaksville, N. C., for the extraction of pure aluminum and its alloys by the Willson process as described above. A large water power is available for driving the dynamo, and it is believed that, with the new process, together with the cheapness of the power, it will be possible to produce aluminum both pure in quality and at a considerably reduced cost.

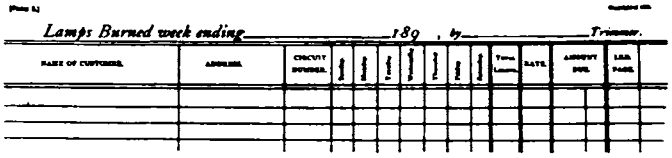
CENTRAL STATION MANAGEMENT AND FINANCE.—IX.

BY

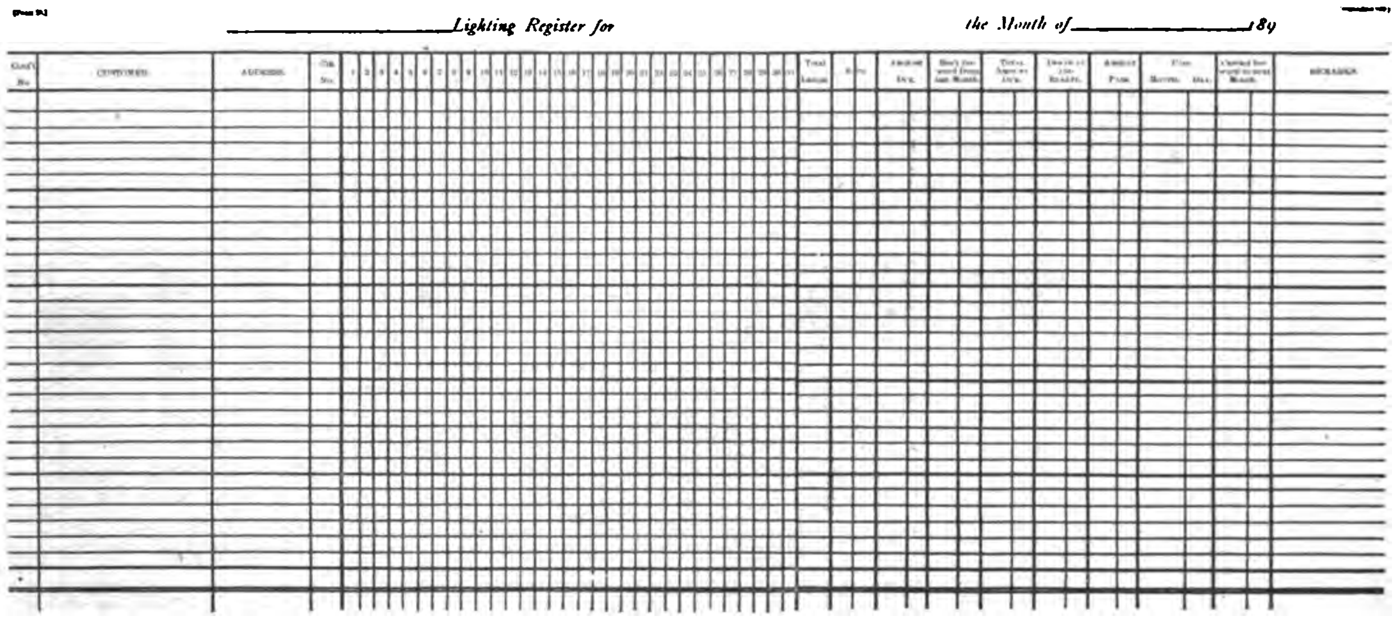
Horatio A. Foster

Department of Accounts.

For convenience of reference it is well to have a contract book with all the proper headings, giving all necessary items and index for reference. If a separate ledger account is kept with each customer, all such data can be put in under the page heading, and is easier of reference than if in a separate book. It will be noticed that the lighting register, form No. 28, has columns for all data necessary to record from installation orders. When the installation is completed the order is returned to the office and filed until the lights are started; then the time of starting is recorded on the slip and all items of record entered in the proper books, such as the lighting register or ledger, the trimmer's book or meter book, circuit register, form No. 28, and posted on the bulletin board, so that inspectors may know where to find it.



Form No. 5.—Inspector's and Trimmer's Blank.



Form No. 28.—Lighting Register.

In respect to methods of reporting arc lamps burned, there are probably as many as there are of running a station. It must be admitted that most of them are negative reports in that only those lamps which did not burn are mentioned, and those not surely.

The writer considers it much better to use what may be called the positive method, and report every lamp trimmed, with the customer's name and location, and for such method advances blank No. 5. It is thought best to make this report on loose sheets which will be written up by the clerk and placed in loose covers, where the trimmer can fill in for the week, and then fresh sheets can be inserted and

THE FISKE RANGE FINDERS.

A naval officer writing from Europe says that while the "Baltimore" was at Toulon nothing aboard the ship excited so much favorable comment from foreigners as the Fiske range finders. "Just now," says the writer, "when our growing navy is accused everywhere of being simply a copy of foreign navies, it is worth while to be able to point out something in which foreign navies admittedly copy us."

the completed ones entered by the clerk in tho lighting register or ledger.

Where stations are full and a load of good, steady customers is connected the sheets can be furnished with the customers' names, all printed in, so as to save a great deal of tedious writing by the clerk every week.

If the old negative method is considered good enough, then form No. 28 for a lighting register is put forward as embodying all the points necessary for either weekly, biweekly, or monthly accounts, and any lamps reported as not burning either by the trimmer or inspector, or both, can be checked off every day and the rest be entered as O. K.

Form No. 5 is also used by the incandescent inspector to record the number of lamps burned daily by customers having monthly or contract rates.

TESLA'S SYSTEM OF ELECTRIC LIGHTING WITH CURRENTS OF HIGH FREQUENCY.

In his lecture delivered before the American Institute of Electrical Engineers,[1] Mr. Nikola Tesla dwelt at length upon the fact that the direct application of electro-magnetic waves to the production of luminous effects was impracticable and that for this purpose electro-static waves or thrusts must be employed. To make these effects available in practice, however, it is necessary to employ currents of very high frequency and of very high potential.

In a patent just issued to Mr. Tesla on this method of electric illumination, he draws attention to the mechanical difficulty of obtaining the necessary high frequency of alternations, and hence he avails himself of the principle of the disruptive discharge. The current of high frequency is produced by the disruptive discharge of the accumulated energy of a condenser maintained by continuously charging the condenser and discharging it disruptively, in connection with an induction coil which generates the high potentials required.

The accompanying diagram, Fig. 1, illustrates the method employed by Mr. Tesla, the generator in this case

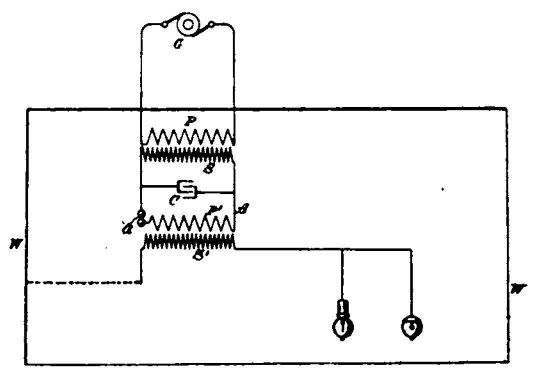
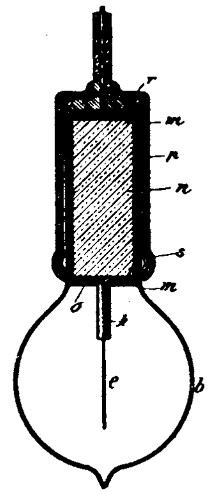


FIG. 1.—TESLA'S NEW SYSTEM OF ELECTRIC LIGHTING.

being one delivering alternate currents of comparatively low potential. The potential of the current is raised by means of an induction-coil having a primary P and a secondary S. Then by the current developed in this secondary a condenser C is charged and this condenser discharged into a circuit A, having an air-gap *a*. By the means above described, a current of enormous frequency is produced. It is next necessary to convert this into a working-circuit of very high potential, for which purpose there is connected up in the circuit A the primary P′ of an induction-coil having a long fine wire secondary S′. The current in the primary P′ develops in the secondary S′ a current or electrical effect of corresponding frequency, but of enormous difference of potential, and the secondary S′ thus becomes the source of the energy to be applied to the purpose of producing light.

The light-giving devices may be connected to either terminal of the secondary S′. If desired, one terminal may be connected to a conducting-wall W of the room to be lighted and the other arranged for connection of the lamps therewith. In such case the walls should be coated with some metallic or conducting substance in order that they may have sufficient conductivity.

Mr. Tesla has devised several forms of lamps to be used



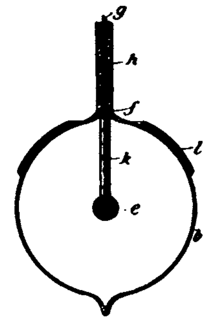


FIG. 2.—TESLA'S LAMP WITH STRAIGHT FILAMENT, ONE INSIDE AND ONE OUTSIDE CONDENSER COATING, AND ONE CONDUCTOR.

FIG. 3.—TESLA'S LAMP WITH INCANDESCENT BALL AND ONE CONDUCTOR.

in connection with his system, two forms of which are shown in the engravings Figs. 2 and 3. In the former the globe *b* is formed with a cylindrical neck, within which is a tube or sheet *m* of conducting material on the side and over the end of a cylinder or plug *n* of insulating material. The lower edges of this tube are in electrical contact with a metallic plate *o*, secured to the cylinder *n*, all the exposed surfaces of the plate and of the other conductors being carefully coated and protected by insulation. The light-giving body *e*, a straight stem of carbon, is electrically connected with the plate by a conductor *f*, which is coated with a refractory insulating material *k*. The neck of the globe fits into a socket composed of an insulating tube or cylinder *p*, with a more or less complete metallic lining *s*, electrically connected by a metallic plate *r* with a conductor *g*, that is attached to one pole of the source of current. The metallic lining *s* and the sheet *m* thus compose the plates of a condenser.

Fig. 3 shows a lamp containing an incandescent body *e* which is connected to one pole of the source of current. Outside of the globe the conducting-wires are protected by a coating of insulation *h*, and inside the globe the supporting-wire is inclosed in and insulated by a coating *k* of a refractory insulating substance, such as pipe-clay. A reflecting-plate *l* is shown applied to the outside of the globe *b*. This form of lamp is a type of those designed for direct electrical connection with one terminal of the source of current; but, as in the case of the lamp, Fig. 2, there need not be a direct connection, for the carbon or other illuminating body may be rendered luminous by inductive action of the current thereon.

ELECTRICITY THE THING.—Discussing the work of the electric car, the Minneapolis *Tribune* says: "Here it is heartily welcomed as a convenience, a civilizer, and a boomer of real estate values."

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VOL. XII. NEW YORK, JULY 1, 1891. No. 165.

The scientific principles which at one period appear of no practical value, and are far removed from popular appreciation, at a later time, in the further development of the subject, become the means of individual prosperity and national wealth.—Joseph Henry.

IS THE DYNAMO A PERFECTED MECHANISM?

IN a recent paper, "On some Points Connected with Mains for Electric Lighting," read by Mr. W. H. Preece, the able electrician in charge of the British postal telegraph system, before the London Institution of Electrical Engineers, he remarked that "it is a pity that some of that redundant mental energy which is endeavoring to raise the efficiency of dynamos and transformers from 94 to 95 per cent. could not be transferred to the question of mains, where real advancement and true economy on a considerable scale are much required."

Taken literally, we are certainly inclined to agree with Mr. Preece that any attempt to further increase the efficiency of the best-constructed dynamos of to-day is hardly worth the time and energy, but, we may ask, are the efforts of inventors to-day directed with this object in view? If we may judge from the work which has been done during the past few years, it can hardly be justly held that such has been the case. On the contrary, we think that an analysis of this work will show that the attempts of dynamo builders have been more in the direction of the improvement of mechanical and electrical design with the view of reaching greater simplicity and cheapening of construction. Indeed, in not a few instances these attempts have been accompanied by a decrease in the efficiency of the machine; but though the dynamo may justly be regarded as one of the most perfect converters of energy, it would be rash to assume that on this account it had reached a condition such that any further modification would be a waste of time and energy. There is still much to be done in both the dynamo and its twin, the converter. In the dynamo, simplicity of construction is still to be striven for, and although the difficulties once experienced with the commutator are now largely overcome, the continuous current machine without the commutator is an object certainly worth striving for. Then again in the case of transformers, their design is still subject to improvement in the direction of increasing the efficiency at light loads. Their low efficiency with light loads has up to the present day been found to detract seriously from their value. Taking all these points into consideration, we believe it would be safe to assume that the final types of dynamo and transformer have not yet been evolved, and that, indeed, they are things in the future. We might even go further and state that, considering the rapid advances and the changes which are becoming manifest in our methods and systems of illumination, it will not take much to render the present types of both the dynamo and transformer obsolete in a very few years.

"GOOD FAN WEATHER."

WE have all of us long been accustomed to hear that it is an ill wind that blows nobody good, and electricians have come to think that it is the best weather for them when there is no wind at all. During the past two or three weeks the country at large has enjoyed its first taste of what has come to be known in electrical circles as "good fan weather," and the result is that the demand for fan motors has been something enormous. People have come to a realizing sense of the fact that it is easy to substitute a fan motor for the little lamp in their office, and the consequence is that without any drumming at all, the orders for these fans have poured in upon the local companies so fast that, to our own knowledge, it has been some days before they could be filled, the customer meanwhile panting and gasping and mopping himself. Some of the companies have not yet bestirred themselves as they should to cultivate this business, thinking it, perhaps, too small to bother about; but we think that with even a little canvassing they would find it very large and very profitable. The addition to the day load of an ordinary station, even if 1,200 or 1,500 fans were running at a time, would not be great enough to require any additional men in the station and there would be the profit not only on the current, but probably on the sale of all the motors too. Moreover, many a man, too, would become familiar with the idea of using electric power and would follow up the little fan motor with something larger for heavier work. We hope to see central stations paying all possible attention to this new business.

As a general thing, the fans give great satisfaction to those who buy them. Some of the complaints made are idle; others are well founded. It seems to us that the fans are very often too large, and create too great a breeze. This is easy to remedy, and might perhaps be helped by having a wider range of sizes. A great many offices are small, and are hot because small, and the customer does not want to run his fan at half speed with the help of a lamp or else run it at full speed and be subjected to a miniature cyclone. Another complaint we have heard from laymen is that the fans are sometimes too noisy and that their insistent hum is trying to nervous people. Here again is a defect that can be remedied. It has also been criticised that the switches are sometimes crude and difficult to get at. This also can be improved upon. All these are minor defects and do not offset the great fact that the electric fan has become as great a boon in hot weather as ice cream or the morning bath. There is no reason why electric fans should not be as plentiful in the land as sewing machines.

THE SUCCESS OF ELECTRIC RAILWAYS.

BECAUSE electricity has been proposed as the motive power for the coming underground rapid transit system of New York, the *Sun* goes out of its way to sneer at what electric roads actually have done in America. Thus, for example, in a paragraph about the old electric road at Asbury Park, whose power-house was visited by fire, it says that electricity did not pay and that the company will go back to horses. It suggests that this might be said of many another road. Well, even if true, what of it? Is steam locomotion a failure because hundreds of roads in this country do not pay, and never have paid? The reason why the visitors to Asbury Park will have to endure horse-car travel this summer is that the company would lose a large part of its season and income while rebuilding its power plant. It may be, also, that the company, while able to put on a few horse teams, would find it very difficult in these close times to raise the money it wanted. But the *Sun* may as well know that if there is one fact it cannot gainsay it is that electric traction is cheaper and better than horse traction. There are some roads that even electricity cannot make pay, but there are a good many more whose only hope and salvation has been found to lie in resort to electric motors. We venture to predict that Asbury Park will soon have a good, modern electric road, replacing the unfortunate pioneer one now destroyed, a road, which for all its crudeness, did very good work.

ALUMINUM PROCESSES.

THE history of the commercial production of the metal aluminum is probably as interesting as that of any metal now employed in the arts. Obtained first by the chemical method, it passed through various modifications from the time of St. Clair Deville until the advent of the electric method of production has within a comparatively short time placed the chemical methods outside the pale of competition. But the attentive observer in the field of electric production of aluminum cannot fail to discern that this method is likely to follow somewhat the chemical methods, in so far as the variety of processes is concerned. Thus when the Messrs. Cowles first drew attention to the possibility of extracting aluminum by the electric method, they employed a process of reduction by means of electric heat in the presence of carbon. In the Héroult process, and in one or two others, the electrolytic action of the current is employed; and the carbon electrode is made the positive and the molten bath the negative electrode.

In this issue we describe still another process, due to Mr. Thomas L. Willson, for which he claims a number of advantages based, no doubt, on good arguments. By employing a hydro-carbon gas as a reducing agent instead of carbon in the solid form, Mr. Willson argues that the reducing agent in the first place is in a perfect form for chemical union with the oxygen of the alumina, and, being already in the gaseous state, no heat is absorbed in the conversion of the solid to the gas before it can act upon the oxygen. Thus a greater heat is obtained for a given expenditure of electrical energy. Besides, according to Mr. Willson, by introducing the hydro-carbon gas under pressure, the reaction and hence the reduction can be effected with any desired rapidity, and, above all, the product may be made pure, on account, evidently, of the purity of the gaseous reducing agent. We are glad to note that the process will be put in commercial operation at an early date and will thus be able to demonstrate on a large scale what has been successfully carried out experimentally.

Mr. Tesla's New System of Illumination.

PENDING the publication of the full report of Mr. Tesla's lecture before the American Institute of Electrical Engineers, we give this week the essential principles embodied in a new system of illumination as embodied in a patent which has just been issued to him. It will be noted that what Mr. Tesla had set before him was to obtain in the first place, alternations of very high frequency by charging and disruptively discharging a condenser, and then raising the potential enormously by means of an induction coil. In other words, Mr. Tesla accomplishes the desired results by exalting the effects which have heretofore been produced in but a feeble manner. It will be noted that though employing alternations in the primary generating apparatus far exceeding those at present in vogue, Mr. Tesla does not depend upon even this high frequency to effect the desired purpose, but introduces the disruptive discharge of the Leyden jar with its well-known enormous frequency as the means for obtaining the required rapidity of alternation. With the method now clearly pointed out, we believe that it will take but a comparatively short time to work out and present to the public the practical details necessary for the general application of such a system.

A New Constant Current Machine.

THE method of regulating constant current arc machines by the shifting of the brushes has become so general that of late comparatively few attempts have been made to vary this method. The simplicity of the plan is no doubt largely accountable for this, and it has been indeed no small problem to beat or better it by an arrangement in which the brushes shall remain stationary. A very ingenious solution, however, has been effected by Mr. F. Tischendoerfer, whose machine and method of regulation are described on another page. At first sight, Mr. Tischendoerfer's machine might appear to be a multipolar dynamo, but it will be evident on closer examination that it is a bi-polar machine in which the pole pieces have been divided into sections with independent windings, by means of which the area of induction can be varied. By cutting out the coils of the field magnets in succession, Mr. Tischendoerfer maintains the neutral point at a fixed position in space, and hence the brushes may also remain fixed. The operation of the machine has shown the method to be one of practical value.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—V.

BY

Chas. Steinmetz.

IV. *Power or Effect.*

The *power*, or the *effect*, of the different E. M. F.'s and currents in the transformer, measured in watts, can be also represented in this polar diagram in a very simple way.

In Fig. 9, as explained in the foregoing, let
$\overline{O E_0}$ = the maximum impressed primary E. M. F.,
$\overline{O E_i}$ = the maximum induced primary E. M. F.,
$\overline{O E}$ = the maximum resulting, or heating, primary E. M. F.,
$\overline{O E_1}$ = the maximum secondary E. M. F.,
$\overline{O C}$ = the maximum primary current,
$\overline{O C_1}$ = the maximum secondary current,
and draw the circles with these lines as diameters, which intersect any ray $\overline{O x}$, representing a certain moment of time, in the instantaneous values of these electric quantities, $\overline{o e_0}$, $\overline{o e_i}$, $\overline{o e}$, $\overline{o e_1}$, $\overline{o c}$, $\overline{o c_1}$.

Then the *effect* of the primary impressed E. M. F. at the time t, that is, at the angle $\vartheta = A O x = \frac{2 \pi t}{T}$, is, $p_0 = o c \times o e_0$.

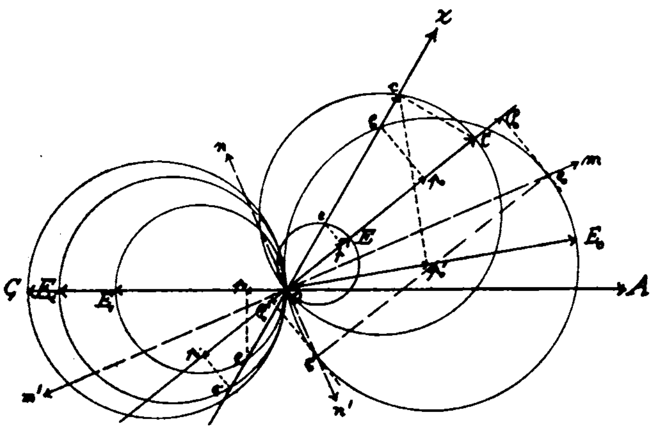


FIG. 9.

Now, connecting c with C, and producing $\overline{e_0 p_0}$ perpendicular to $\overline{O C}$, we get two similar triangles, $o c C \sim o p_0 e_0$. Hence, by the well-known relations of similarity, we get, $\overline{o c} : \overline{O C} = \overline{o p_0} : \overline{o e_0}$; or, $\overline{o c} \times \overline{o e_0} = \overline{o p_0} \times \overline{O C}$, whence:

"*The instantaneous value of the effect of impressed primary* E. M. F., $e_0 = \overline{o e_0}$, *at any time is given by its projection* $p_0 = \overline{o p_0}$ *upon the maximum value of the primary current* $C = \overline{O C}$, *multiplied into this primary current.*"

Or, in the same way:

"*By the projection of the instantaneous value of the primary current,* $p_0{}^1 = \overline{o p_0{}^1}$ *upon the maximum primary impressed* E. M. F.: $E_0 = \overline{O E_0}$, *multiplied into this primary* E. M. F."

The first representation will be more conveniently used, when the power of the different E. M. F.'s, acting in the same circuit, that is, with the same current, is to be compared; the latter representation, when the same E. M. F. produces several currents. The *effect of the induced primary* E. M. F. e_i is given by the length: $p_i = \overline{o p_i}$, multiplied into $C = \overline{O C}$. The *effect of the heatiug* E. M. F.: e is: $\overline{o p} \times C$.

In the same way, we derive the instantaneous *power-value of the secondary circuit* by the projection $o p_1$ of the secondary E. M. F. $\overline{o e_1}$ upon the maximum secondary current, $\overline{O C_1}$, multiplied into $C = \overline{O C_1}$.

For instance, in the transformer treated as an example, for the time $t = \frac{T}{6}$, that is at the angle $\vartheta = A O x = 60°$, the *whole effect of the primary circuit* is given by $o p_0$ = 1.035 inch, and $O C$ = 1.44 inch; hence, $o p_0 \times O C$ = 1.49 square inch.

Now, 1 ampere = .03 inch, and 1 volt = .01 inch; hence, 1 watt = .0003 square inch, and, therefore, 1.49 square inch = 4962 watts. That is: $p_0 = \overline{o p_0} \times \overline{O C}$ = 4962 watts.

In the same way, the effect of the *induced primary* E. M. F., $\overline{o p_i}$ = —.618 inch, $\overline{O C}$ = 1.44 inch, $o p_i \times \overline{O C}$ = —.889 square inch, p_i = — 2962 watts, therefore negative. That is: the induced primary E. M. F. consumes energy in the primary circuit, and gives it back in the secondary circuit.

Heating effect of the primary current, $\overline{o p}$ =.417 inch. $\overline{O C}$ =1.44 inch, $\overline{o p} \times \overline{O C}$ =.60 square inch, p = 2,000 ampere turns.

The heating effect is the only one, which must always be positive, that is, must consume energy, just as in mechanical engineering, the effect of frictional resistance must always be positive.[1]

From this we get the equation, $p = p_0 + p_i$, or, 2,000 = 4962 — 2962, the *law of conservation of energy*, derived from the *parallelogram-law* of *sine waves.*

Or inversely, when starting from the equation, $p = p_0 + p_i$, we derive the *parallelogram-law* of sine waves from the law of *conservation of energy*, as pointed out before.

The *effect of the secondary circuit* is, $\overline{o p_1}$ =.25 inch, $\overline{O C_1}$ =1.5 inch, $o p_1 \times O C_1$ =.375 square inch, p_1 = 1250 watts, always *positive*, so long as no self-induction is acting.

From this we derive the *magnetizing effect*, that is, the energy converted into magnetism, $p_m = -p_i - p_1$ = 2962 — 1250 = 1712 watts; that is, at this moment electric energy is transformed into magnetic potential energy; and the magnetism rises.

If no self-induction is present, the *effect of the secondary current twice* during each period equals zero, at the angles, $90° = \frac{T}{4}$, and $270° = \frac{3\,T}{4}$.

It is a maximum for the angles 0° and $180° = \frac{T}{2}$, and is then $\overline{O E_1} \times \overline{O C_1}$ = 1.5 square inch = 5000 watts.

The whole *energy of the primary circuit* equals zero *four times* per period, for the angles $90° + \varphi = 128.7°$ and $270° + \varphi = 308.7°$, where the current = 0, and $90° + \psi = 100°$, and $270° + \psi = 280°$, where the impressed E. M. F. = 0, and is always positive except between the angles $90° + \psi = 100°$ and $90° + \varphi = 128.7°$, and $270° + \psi = 280°$ and $270° + \varphi = 308.7°$, where it becomes negative. Hence:

Twice during each period the transformer gives back energy to the line and to the dynamo.

The effect of the secondary current always being positive, meaning *consumption* of energy, the energy given back by the transformer to the primary circuit is converted from magnetic potential energy into electric energy. Four times during each period the effect of the primary impressed E. M. F. reaches a maximum.

We find these maxima, by laying off a tangent on the circle e_0, perpendicular to C.

Two tangents: $P_0 e_0$ and $P_0' e_0'$ being possible, we derive two points P_0 and P_0', the one P_0 giving the two *positive* maxima of the *impressed energy:*

$P_0 = \overline{O P_0} \times \overline{O C}$ = 1.624 × 1.44 = 2.34 square inch = 7800 watts for the angles, 24.35° and 204.35°.

1. Or always negative, when counting *production* of energy positive.

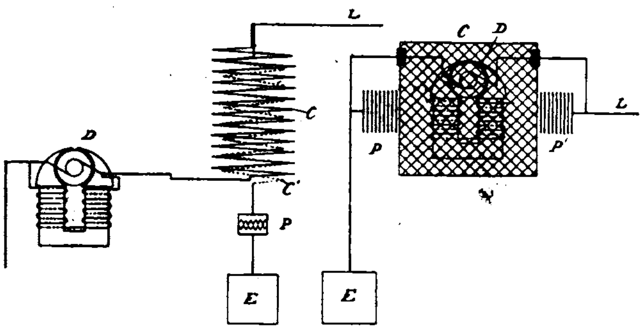
The other, P_0', gives the two *negative* maxima of the impressed energy: $P_0' = \overline{o\,p_0'} \times \overline{o\,c} = -.104 \times 1.44 = -.15$ square inch, $= -500$ watts for the angles 114.35° and 294.35°; that is, perpendicular to the positive maxima. These four maxima lie in the middle between the four zero-values of the impressed energy.

In the same manner we find for the *induced primary* E. M. F., 2 positive and 2 smaller negative maxima, in the middle between the 4 zero values, but for the primary resulting, or heating E. M. F. only 2 positive maxima and 2 zero values exist. In the same way, by using the diagram, Fig. 8, containing the working of the hysteresis and the eddies also, we derive the effect for this more complete diagram.

But Fig. 8 allows us also to estimate the energy consumed by hysteresis and by eddies. This offering no new difficulties, we may be allowed to suppress it here.

THOMSON'S NEW LIGHTNING ARRESTER.

A METHOD of supplementing the action of the ordinary lightning arrester in protecting dynamos, motors, and other apparatus from lightning or other high potential discharges has recently been devised by Prof. Elihu Thomson, and is illustrated in the accompanying engravings. It consists, briefly, in causing the discharge, when passing to earth, to generate, by induction, a counter-electromotive force which opposes its passage through the apparatus to be protected. In the illustrations, Figs. 1 and 2, L represents a line circuit, in which is included the dynamo D, generating either direct or alternating current, as the case may be, the protector being equally applicable to all systems of distribution. The line-wire is connected to ground at one end of the circuit, and at the other end there are two conducting paths to ground, one, the ordinary lightning-discharge path, shunting the generator by way of arrester-plates P and ground-plate E and including also a few turns of wire C′, while the second comprises a corresponding coil C, which may be interior or exterior to the coil C′ and passes through the generator to ground. These two coils are arranged in inductive relation to one another, but are well insulated. Their effect is to cause a lightning or other static discharge when passing directly to ground through the path of comparatively low self-induction and coil C′ to generate an opposing counter-electromotive force from the generator



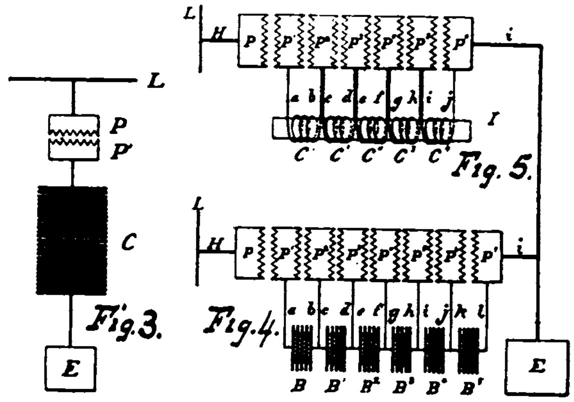
FIGS. 1 AND 2.—THOMSON'S COUNTER E. M. F. LIGHTNING ARRESTER.

to the line in the other coil C, and in this way to balance the inductive effects.

In Fig. 2 the coil C in the direct lightning-discharge path is, in effect, an exterior casing or basket-work of metal, which surrounds the dynamo, while the windings of the machine itself serve as the second coil, corresponding to C in Fig. 1. The connection from the line and earth-plate to the casing C may be made either directly or through a series of insulated plates PP′, which are separated by a small interval, enabling a static discharge to pass throughout the series and preventing the continuance of an arc between individual plates on account of the number of spark-gaps in series. The passage of an inductive discharge from the line by way of the cage C, shunting the generator, will set up a counter-induction effect in the windings of the dynamo itself, and these two will oppose one another, so that the dynamo will be thoroughly protected.

Figs. 3, 4 and 5 show other forms of lightning arrester, embodying the same principle, also invented by Prof. Thomson, in which are placed a number of polarizing cells in series with the discharge-plates and divided into sections, each section being shunted by the plates.

In Fig. 3 the generator C is arranged between the arrester-plate P′ and earth-plate E, while in Fig. 4 the successive sets or sections of polarizing-cells B B′ B², &c., are placed in series with the discharge-plates P P′, and each set or section



FIGS. 3, 4 AND 5.—THOMSON'S COUNTER E. M. F. LIGHTNING ARRESTER.

is connected in shunt by connections *a b c*, &c., with the discharge-plates P′ P² P³, &c., which are arranged in series with one another and also in series with the discharge or jumping space between P P′. The counter-electromotive force generated by each set or section of the polarizing-cells is made insufficient to sustain an arc between the arrester-plates in shunt, so that the discharge goes to earth either wholly or partly through the cells; but a sufficient kick or back electromotive force is generated by the polarization of the cells to extinguish the arc between the plates P P′.

In case alternating currents are employed, counter-inductive devices C C′ C², &c., are substituted for the polarizing-cells in the manner shown in Fig. 5.

THE USE OF LEAD AMALGAM IN ACCUMULATORS.

MONS. NÉZEREAU has recently been again directing his attention to the subject of accumulators. It will be remembered that his earliest work referred to the use of juxtaposed amalgams. The active material of this modified accumulator consisted of spongy lead, which was obtained by eliminating mercury from an amalgam of lead (Hg : Pb : : 1 : 2); this was fused and the cold crystalline mass was then powdered and compressed into a grating set in a frame, and after being hardened by immersion in dilute sulphuric acid and subsequent exposure to the air the prepared plates were then ready for the action of the forming current. These early accumulators of Nézereau, it may be remembered, had a capacity reaching as high as 25 ampere hours per kilogramme of plates, but they were costly to make. Nézereau has observed that in the case of accumulators in which spongy lead is the active material, this material in the positive electrodes, especially in the neighborhood of the supports, is very rapidly acted upon chemically, moreover the agglomerated materials do not form with the metal a sufficiently intimate and conducting layer. He finds that it is only necessary to cover the polar surfaces with a spongy layer of 4 millimetres thickness, for this distance appears to be the limit of the destructive action of the charging current.

ELECTRIC DISCHARGE IN VACUUM TUBES.

BY

Nikola Tesla

In THE ELECTRICAL ENGINEER of June 10, I have noted the description of some experiments of Prof. J. J. Thomson, on the "Electric Discharge in Vacuum Tubes," and in your issue of June 24 Prof. Elihu Thomson describes an experiment of the same kind. The fundamental idea in these experiments is to set up an electromotive force in a vacuum tube—preferably devoid of any electrodes—by means of electro-magnetic induction, and to excite the tube in this manner.

As I view the subject, I should think that to any experimenter who has carefully studied the problem confronting us and who has attempted to find a solution of it, this idea must present itself as naturally, as, for instance, the idea of replacing the tinfoil coatings of a Leyden jar by rarefied gas and exciting luminosity in the condenser thus obtained by repeatedly charging and discharging it. The idea being

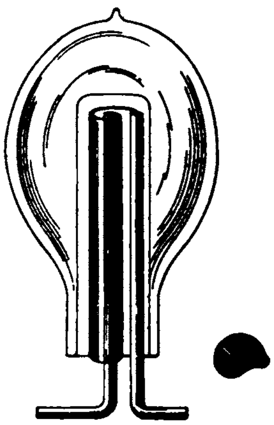


FIG. 1.

obvious, whatever merit there is in this line of investigation must depend upon the completeness of the study of the subject and the correctness of the observations. The following lines are not penned with any desire on my part to put myself on record as one who has performed similar experiments, but with a desire to assist other experimenters by pointing out certain peculiarities of the phenomena observed, which, to all appearances, have not been noted by Prof. J. J. Thomson, who, however, seems to have gone about systematically in his investigations and who has been the first to make his results known. These peculiarities noted by me would seem to be at variance with the views of Prof. J. J. Thomson, and present the phenomena in a different light.

My investigations in his line occupied me principally during the winter and spring of the past year. During this time many different experiments were performed, and in my exchanges of ideas on this subject with Mr. Alfred S. Brown, of the Western Union Telegraph Company, various different dispositions were suggested which were carried out by me in practice. Fig. 1 may serve as an example of one of the many forms of apparatus used. This consisted of a large glass tube sealed at one end and projecting into an ordinary incandescent lamp bulb. The primary, usually consisting of a few turns of thick, well-insulated copper sheet was inserted within the tube, the inside space of the bulb furnishing the secondary. This form of apparatus was arrived at after some experimenting and was used principally with the view of enabling me to place a polished reflecting surface in the inside of the tube, and for this purpose the last turn of the primary was covered with a thin silver sheet. In all forms of apparatus used there was no special difficulty in exciting a luminous circle or cylinder in proximity to the primary.

As to the number of turns, I cannot quite understand why Prof. J. J. Thomson should think that a few turns were "quite sufficient," but lest I should impute to him an opinion he may not have, I will add that I have gained

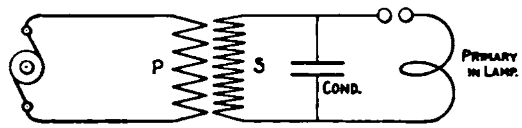


FIG. 2.

this impression from the reading of the published abstracts of his lecture. Clearly, the number of turns which gives the best result in any case, is dependent on the dimensions of the apparatus, and, were it not for various considerations, one turn would always give the best result.

I have found that it is preferable to use in these experiments an alternate current machine giving a moderate number of alternations per second to excite the induction coil for charging the Leyden jar which discharges through the primary—shown diagrammatically in Fig. 2,—as in such case, before the disruptive discharge takes place the tube or bulb is slightly excited and the formation of the luminous circle is decidedly facilitated. But I have also used a Wimshurst machine in some experiments.

Prof. J. J. Thomson's view of the phenomena under consideration seems to be that they are wholly due to electro-magnetic action. I was, at one time, of the same opinion, but upon carefully investigating the subject I was led to the conviction that they are more of an electrostatic nature. It must be remembered that in these experiments we have to deal with primary currents of an enormous frequency or rate of change and of a high potential, and that the secondary conductor consists of a rarefied gas, and that under such conditions electrostatic effects must play an important part.

In support of my view I will describe a few experiments made by me. To excite luminosity in the tube it is not

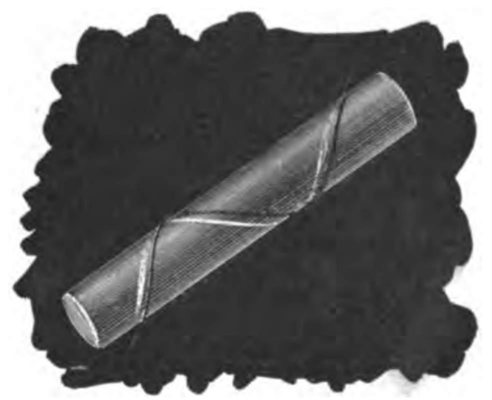


FIG. 3.

absolutely necessary that the conductor should be closed. For instance, if an ordinary exhausted tube (preferably of large diameter) be surrounded by a spiral of thick copper wire serving as the primary, a feebly luminous spiral may be induced in the tube, roughly shown in Fig. 3. In one of these experiments a curious phenomenon was observed; namely, two intensely luminous circles, each of them close to a turn of the primary spiral, were formed inside of the tube, and I attributed this phenomenon to the existence of nodes on the primary. The circles were connected by a faint luminous spiral parallel to the primary and in close proximity to it. To produce this effect I have found it necessary to strain the jar to the utmost. The turns of the spiral tend to close and form circles, but this, of course, would be expected, and does not necessarily indicate an electro-magnetic effect; whereas the fact that a glow can be produced along the primary in the form of an open spiral argues for an electrostatic effect.

In using Dr. Lodge's recoil circuit, the electrostatic action is likewise apparent. The arrangement is illustrated

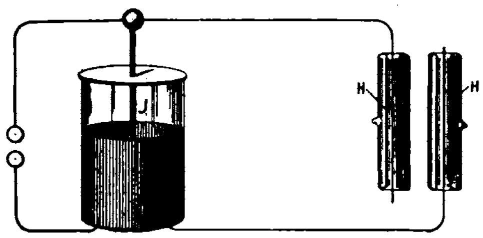


FIG. 4.

in Fig. 4. In his experiment two hollow exhausted tubes H H were slipped over the wires of the recoil circuit and upon discharging the jar in the usual manner luminosity was excited in the tubes.

Another experiment performed is illustrated in Fig. 5. In this case an ordinary lamp-bulb was surrounded by one or two turns of thick copper wire P and a luminous circle L excited in the bulb by discharging the jar through the primary. The lamp-bulb was provided with a tinfoil coating on the side opposite to the primary and each time the tinfoil coating was connected to the ground or to a large object the luminosity of the circle was considerably increased. This was evidently due to electrostatic action.

In other experiments I have noted that when the primary touches the glass the luminous circle is easier produced and is more sharply defined; but I have not noted that, generally speaking, the circles induced were very sharply defined, as Prof. J. J. Thomson has observed; on the contrary, in my experiments they were broad and often the whole of the bulb or tube was illuminated; and in one case I have observed an intensely purplish glow, to which Prof. J. J. Thomson refers. But the circles were always in close proximity to the primary and were considerably easier pro-

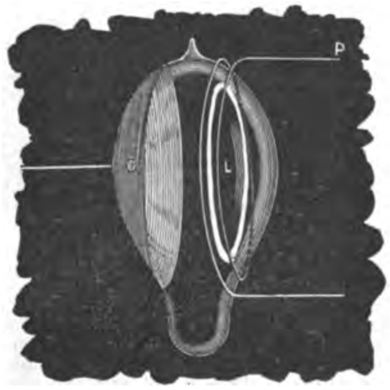


FIG. 5.

duced when the latter was very close to the glass, much more so than would be expected assuming the action to be electromagnetic and considering the distance; and these facts speak for an electrostatic effect.

Furthermore I have observed that there is a molecular bombardment in the plane of the luminous circle at right angles to the glass—supposing the circle to be in the plane of the primary—this bombardment being evident from the rapid heating of the glass near the primary. Were the bombardment not at right angles to the glass the heating could not be so rapid. If there is a circumferential movement of the molecules constituting the luminous circle, I have thought that it might be rendered manifest by placing within the tube or bulb, radially to the circle, a thin plate of mica coated with some phosphorescent material, and another such plate tangentially to the circle. If the molecules would move circumferentially, the former plate would be rendered more intensely phosphorescent. For want of time I have, however, not been able to perform the experiment.

Another observation made by me was that when the specific inductive capacity of the medium between the primary and secondary is increased, the inductive effect is augmented. This is roughly illustrated in Fig. 6. In this case luminosity was excited in an exhausted tube or bulb B and a glass tube T slipped between the primary and the bulb, when the effect pointed out was noted. Were the action wholly electromagnetic no change could possibly have been observed.

I have likewise noted that when a bulb is surrounded by a wire closed upon itself and in the plane of the primary, the formation of the luminous circle within the bulb is not prevented. But if instead of the wire a broad strip of tinfoil is glued upon the bulb, the formation of the luminous band was prevented because then the action was distributed over a greater surface. The effect of the closed tinfoil was no doubt of an electrostatic nature, for it pre-

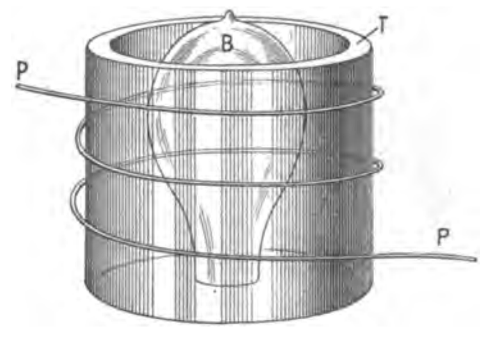


FIG. 6.

sented a much greater resistance than the closed wire and produced therefore a much smaller electromagnetic effect.

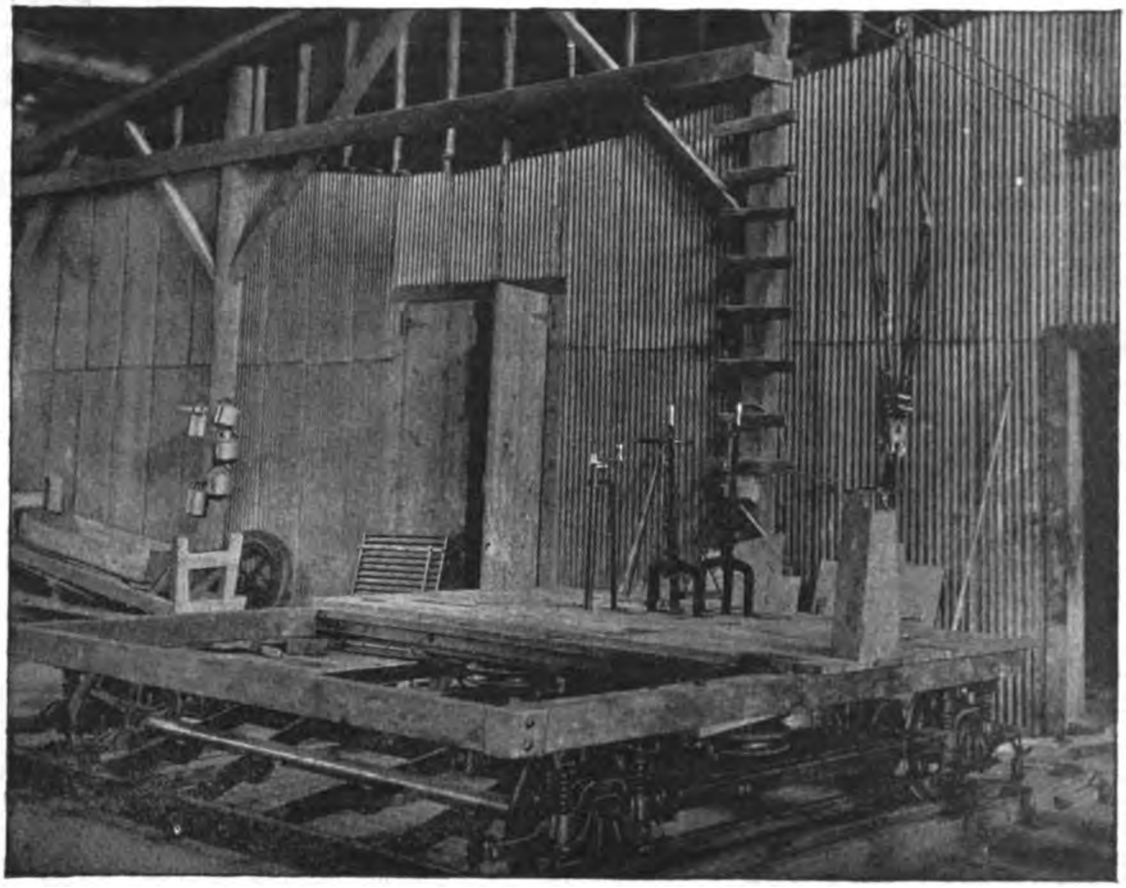
Some of the experiments of Prof. J. J. Thomson also would seem to show some electrostatic action. For instance, in the experiment with the bulb enclosed in a bell jar, I should think that when the latter is exhausted so far that the gas enclosed reaches the maximum conductivity, the formation of the circle in the bulb and jar is prevented because of the space surrounding the primary being highly conducting; when the jar is further exhausted the conductivity of the space around the primary diminshes and the circles appear necessarily first in the bell jar as the rarefied gas is nearer to the primary. But were the inductive effect very powerful they would probably appear in the bulb also. If, however, the bell jar were exhausted to the highest degree they would very likely show themselves in the bulb only, that is, supposing the vacuous space to be non-conducting. On the assumption that in these phenomena electrostatic actions are concerned we find it easily explicable why the introduction of mercury or the heating of the bulb prevents the formation of the luminous band or shorten the after-glow; and also why in some cases a platinum wire may prevent the excitation of the tube. Nevertheless some of the experiments of Prof. J. J. Thomson would seem to indicate an electro-magnetic effect. I may add that in one of my experiments in which a vacuum was produced in the Toricellian method, I was unable to produce the luminous band, but this may have been due to the weak exciting current employed.

My principal argument is the following: I have experimentally proved that if the same discharge which is barely sufficient to excite a luminous band in the bulb when passed through the primary circuit be so directed as to exalt the electrostatic inductive effect—namely, by converting upwards—an exhausted tube, devoid of electrodes, may be excited at a distance of several feet.

ELECTRIC MOTORS IN A GLASS FACTORY.

THE demand of mills and manufactories for a safe, reliable and economical method of transporting raw materials and manufactured products about the works or to and from the railway station has led to the adoption of the electric tramway. The Thomson-Houston Motor Co., of Boston, have recently installed such a tramway at the works of the Pittsburgh Plate Glass Co., of Ford City, Pa. This installation is especially interesting owing to the peculiar conditions under which it is working, and furnishes a good example of the wonderful possibilities of the application of electric power The purpose for which the tramway is used is transferring the immense plates of glass in process of manufacture from one part of the works to another.

Four locomotives, one of which forms the subject of the accompanying illustration, are in use, each being equipped with a twenty horse-power Thomson-Houston motor. This motor is used not only to propel the locomotive, but also to drive a hoisting drum, which by means of special gearing is thrown in or out at will.



ELECTRIC MOTOR, FORD CITY, PA., GLASS WORKS.

Glass is loaded on cars which run on tracks at right angles to the main track, and the hoisting apparatus above mentioned is used to pull these cars up to the tow-cars, which run on the main track and are hauled by the locomotives. The tow-cars are ordinary platform trucks. The grade of the main track is such that the platforms of the trucks are on a level with the side track, and the cars when loaded are placed on the trucks and then transferred to any desired point.

There are two lines of main track, both of which are entirely inside the works, and each of which is about 700 feet in length. The guage of the road is nine feet and ten inches (9′ 10″), which is probably the broadest gauge ever used in tramway work. The overhead single wire construction is used and the current for the operation of the motor car is generated by a 500 volt Thomson-Houston generator of the class known as M. P. 75.

MR. HENRY HARMON NEILL, a journalist well known in electrical circles and a member of the *Commercial Advertiser* editorial staff for some time past, has now become editor-in-charge of the editorial page of that excellent and time honored evening journal.

Literature.

Electricity and Its Recent Applications. By Edward Trevert. *D. Van Nostrand Co.* New York, 1891. Illus., 346 pages, cloth. Price, $2.

This book, issued by the Bubier Publishing Co. of Lynn, and published by the D. Van Nostrand Co., is an excellent addition to the books treating electricity in a popular way. It is intended more particularly for students and amateurs, and hits their needs pretty closely. Mr. Trevert has made other successful essays in this line, and has a great knack of stating the essential facts in a simple, lucid manner. He greatly prefers fact to theory, and might even be said to slight the latter, yet he gives enough to furnish an intelligent idea of the principles lying at the bottom of the science and art.

The book is divided into twenty chapters, which range through the whole field of applied electricity. Some of the chapters will be read with great avidity, especially those which tell how to make things, such as bells, motors, induction coils, &c. Many of the chapters are new also in the subjects of which they treat, including electric mining, electric welding, the electric railway, &c. There are several valuable chapters telling just how to handle electric gas-lighting circuits, how to test, how to make measuring instruments, &c. Wherever possible, Mr. Trevert has introduced cuts of the newest apparatus of all kinds, so that the reader must feel that he is put abreast of the very last work and invention of the day. Here and there a better or more correct phraseology might be employed, but the general treatment is well designed and thoroughly meritorious.

At the end of the book is a brief glossary, but one cannot help regretting the absence of a good index. The book is too useful altogether to be issued without one, and we do hope the lack will be supplied hereafter. The book is well printed in large type, on good paper, and is strongly bound. There will be a great many readers to appreciate Mr. Trevert's plain, honest treatment of his subject.

MR. PETER CLAUS has just been appointed New York representative of the Germania Electric Co., of Boston, for their incandescent lamps, with headquarters in New York.

CARE AND MAINTENANCE OF ELECTRIC BLOCK SIGNALS.[1]

BY C. L. LANG.

ELECTRIC signals for keeping trains a certain distance apart, commonly called "block signals," are slowly but surely coming into use. No argument is necessary to demonstrate the value of such appliances, so the matter settles itself into a question of cost. Ordinarily not a word has been said about the cost of maintenance, so the railroad official gets the idea that to once equip his road with signals the cost stops; that they will run themselves, so to speak, displaying automatically, and continuously, with almost the intelligence of a human being. The signals are ordered, placed in position, and are found to work splendidly.

Soon, engineers begin to report signals out of order; standing at "danger" improperly. The road master is probably notified, who knows no more about it than a child, except that it is "electric"; so he hunts up the telegraph lineman, who knows but little more. The result soon is, that all the signals are at "danger," and the company putting them in is notified that the signals are a failure. Upon investigation the signal company usually finds the whole trouble to be *want of care*. Thus we see the signals have got a bad reputation through no fault of their own, while the general manager discovers that the first cost is but the beginning of the expense.

As my experience has been mainly with a battery signal, what I say will more particularly have reference to the systems using a battery.

First of all, select an intelligent man to take care of your signals, and impress upon him that eternal vigilance is the price of a perfect working signal. He should clean his battery zincs very often to keep the internal resistance at the minimum, the external resistance being merely nominal. A point not generally understood by battery men is, that a battery that will work a 4 ohm sounder for two weeks will only work a signal circuit of half an ohm resistance one week.

When the zinc becomes reduced one-half in size we do not notice it in a circuit of high resistance, but it is fatal to a circuit of very low resistance. In our service we have two circuits of different resistance; one from one-half to two ohms; the other from ten to twenty ohms. We transfer the half-consumed zincs from the low to the higher resistance circuits, keeping up the efficiency of both batteries. Before leaving the subject of batteries I want to say that fully nine-tenths of the failures recorded on block signals can be legitimately charged to the battery, showing that this is the main point to watch.

Another point that, if carefully and intelligently watched will save much anxiety and search for cause of trouble, is the relay. Every relay should be hermetically sealed so no dust can prevent the points from making sure and perfect connection. Every relay should be protected by a lightning arrester of some kind, as, strange as it may appear, relays in a circuit made up of the steel rails of the track and underground wires with no line wire whatever, are often burned by lightning. Where the track is used as the circuit the joints are usually bridged by wires fastened to the rails by rivets driven into holes drilled for the purpose. Here is something that requires very close watching. The track workmen are often ignorant, careless, or both, breaking the wires or loosening the wires on the rivets. A detecting galvanometer is a very valuable help in locating faults of this nature.

In systems using the tracks for the circuit, insulations are necessary to divide the track into suitable signal sections, as well as for other purposes. These require great care in first introducing, as well as careful watching from day to day. The insulating material may be of wood, vulcanized fibre, leatheroid, laminar fibre or other suitable material. The exact manner of introducing these insulations varies on different roads.

The cost per signal for maintenance of double track block signals is not far from $40.00 per annum, varying somewhat according to the traffic. Notwithstanding the expense of installing a complete signal system, and expense of care, I believe their use to be an economy when the traffic is as heavy as is the case on some parts of most of our leading railroads.

By the aid of these automatic signals trains are run into, and out of, our cities safely at intervals of one, two or three minutes, regardless of fog or weather. Without signals this could not be safely accomplished. As I remarked in the beginning, the perfect working signal displays intelligence little short of human; never sleeps on duty, and never gets drunk.

THE WRITING TELEGRAPH.

A test of the writing telegraph between New York and Chicago was made recently, and, allowing for atmospheric disturbances, was fairly successful. A message of sixty words was transmitted without a break, and was recorded automatically by a pen attached to the transmitting instrument.

1. Abstract of a paper read at the 10th Annual Meeting of the Association of Railway Telegraph Superintendents, Cincinnati, O., June 18, 1891.

Society and Club Notes.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.

THE Tenth Annual Meeting of this Association was called to order by President G. T. Williams, at the Grand Hotel, Cincinnati, Wednesday, June 17th, at 10:30 A. M. The following members were present:

G. T. Williams, President, Cleveland, O.; P. W. Drew, Secretary and Treasurer, Chicago, Ill.; C. Selden, B. & O. R. R., Baltimore, Md.; A. R. Swift, C., R. I. & P. R. R., Chicago, Ill.; C. W. Hammond, Mo. Pac. R. R., St. Louis, Mo.; M. B. Leonard, C. & O. R. R., Richmond, Va.; C. S. Jones, Ill. Cen. R. R., Chicago, Ill.; E. A. Darlton, R. & D. R. R., Washington, D. C.; G. L. Lang, N. Y. & N. E. R. R., Boston, Mass.; G. M. Dugan, Ill. Central R. R., Jackson, Tenn.; T. J. Higgins, C., C., C. & St. L. R. R., Cleveland, O.; S. K. Bullard, M., K. & T. R. R., Sedalia, Mo.; H. C. Sprague, K. C., Ft. S. & M. R. R., Kansas City, Mo.; U. J. Fry, C. M. & St. P. R'y, Milwaukee, Wis.; C. H. Smith, I., I. & I. R. R., Kankakee, Ill.; A. R. Lingafelt, C., R. I. & P. R. R., Topeka, Kan.; Robert Stewart, C. R. R. of N. J., Elizabeth, N. J.; H. C. Reed, M., L. S. & W. R. R., Milwaukee, Wis.; J. B. Stewart, West Shore R. R., Weehawken, N. J.; J. W. Stacey, Tex. & Pac. R. R., Marshall, Tex.; W. C. Walstrum, N. & W. R. R., Roanoke, Va.; T. W. Parks, I. & G. N., Tyler, Tex.; S. S. Bogart, (Honorary Member), New York, N. Y.; R. J. M. Danley, C., S. & H. Ry., Columbus, O.; F. M. Duncan, D. & R. G., Denver, Col.; F. W. Wilson, G. R. & I. R. R., Fort Wayne, Ind.; A. Hayward, O. & M., Cincinnati, O.; K. McKenzie, M. & O., Jackson, Tenn.; E. R. Adams, P. & R. R. R., Reading, Pa.; W. D. Vincent, B. & O. R. R., Pittsburgh, Pa.; W. P. McFarlane, F. E. & M. V., Omaha, Nev.; G. R. Kimball, B. & O., Newark, O.; J. L. Orbison, C., H. & D. R. R., Cincinnati, O.; H. C. Hope, C., St. P., M. & O R. R., St. Paul, Minn.; Horace Johnson, C., W. & B. R. R., Chillicothe, O.; W. P. Ward, B., C. R. & N., Cedar Rapids, Ia.

Twenty-one new members were elected as follows:

H. J. Adams, B. & M. R. R., Alliance, Neb.; J. H. Jacoby, Lehigh Valley R. R., Bethlehem, Pa.; W. P. Ward, B., C. R. & N. R. R., Cedar Rapids, Ia.; A. D. Halliday, D. & I. R. R. R., Two Harbors, Minn.; J. P. Boyle, K. & W. R. R., Centreville, Ia.; W. P. Mc Farlane, F., E. & M. V. R. R., Omaha, Neb.; G. E. Evans, L. & N. R. R., Louisville, Ky.; E. R. Adams, P. & R. R. R., Reading, Pa.; C. G. Sholes, A., T. & S. F. R. R., Chicago, Ill.; K. McKenzie, M. & O. R. R., Jackson, Tenn.; W. D. Vincent, B. & O. R. R., Pittsburgh, Pa.; J. M. Eagan, St. L. & S. F. R. R., Springfield, Mo.; R. J. M. Danley, C., S. & H. Ry., Columbus, O.; G. R. Kimball, B. & O. R. R., Newark, O.; E. R. Scoville, B. O. & S. W. R. R., Chillicothe, O.; H. G. Johnston, I., I. & I. R. R., Kankakee, Ill.; W. W. Jackson, N. Y. & N. E. R. R., Providence, R. I.; J. W. Dawson, K. & M. Ry., Charleston, W. Va.; F. Peters, S. P. R. R., New Orleans.

Mr. Chas. S. Jones, Ill. Central R. R., Chicago Ill., was elected President, and L. H. Korty, U. P. R. R., Omaha., Vice-President for the ensuing year. P. W. Drew, of Chicago, was re-elected Secretary and Treasurer.

It was voted unanimously to hold the 11th meeting of the Association at Denver, on June 15th, 1892.

In discussing Mr. Lang's paper,[1] MR. ROBERT STEWART said that on the Central R. R. of N. J. trains were started out from ¼ to ½ minute apart, some of the blocks being comparatively short.

In reply to an inquiry regarding damage from lightning, MR. LANG said that during an electrical storm in May seven relays were burned out which were connected with a track circuit, and had not more than ten feet of line wire. Previous to this storm they had not used lightning arresters for track circuits, but did so now. The form adopted was made of two plates of copper separated by paraffined paper.

MR. WILLIAMS stated that several years ago on the Pan Handle Road near Dalton, Ill., he saw 18 poles which had been struck and destroyed by lightning, although no wires were on them, it being a new line of poles. On the other side of the track the poles having wires on them were not disturbed.

MR. M. B. LEONARD, of the Chesapeake and Ohio Railroad, read a paper on the "Phonoplex for Railway Telegraph Lines." He said that with the increase of traffic there was a corresponding growth in the use of the railway telegraph, but it was frequently difficult for a superintendent to obtain additional facilities. It had therefore been necessary in many cases to adopt devices used by commercial telegraph companies to increase the carrying capacity of the wires. The phonoplex, besides increasing the capacity of existing lines, possessed several distinct advantages over the Morse apparatus. Its operation was not affected by the weather. In most instances it would work over a break in the wire where parallel wires existed, the induced current jumping over to the companion wire and thus bridging the break. The phonoplex

1. See this page.

formed a never-failing means of communication with all offices. The battery now used in connection with it is the Edison-Lalande. On the Chesapeake and Ohio line during the December blizzard all the wires were down between Clinton Forge and Richmond. The Phonoplex worked steadily until the other wires were cleared up. The Kansas City and Fort Scott Railway had had a similar experience. He believed that in the Chesapeake and Ohio service the system had paid for itself several times over.

In response to an inquiry as to the nature of the damage to the line referred to, MR. LEONARD said that the wire was broken, crossed and grounded. They worked through the break by the induced current, but could not say which wire it was on. There were four stations between Clinton Forge and Richmond. The operation of the phonoplex could only be stopped by an absolute break where there was no other wire for the current to pass over.

MR. ROBERT STEWART inquired if it would work through a leaky wire in a 7-conductor cable a mile in length; if so, it would be valuable, as cables were expensive. No positive reply was elicited to this inquiry. MR. LANG stated that it could not be worked on two wires strung on the same set of poles.

MR. SELDEN stated that the B. & O. R. R. Co. has a wire 120 miles long with 30 stations which they wished to have equipped with the phonoplex, but after several months experimenting, the attempt was abandoned as impracticable. He confirmed Mr. Leonard's statement that it would work over a break under the conditions stated. The B. & O. R. R. has a set working between Philadelphia and Baltimore, and several sets in N. Y. City. Their longest circuit was 91 miles, but circuits 30 miles long were worked on other roads.

MR. LANG stated that between Hartford and Boston the phonoplex worked admirably up to within 40 rods of the Boston office, where the wire entered a cable 75 feet in length, which contained a W. U. ticker wire. That made it practically useless.

MR. U. J. FRY, of the Chicago Milwaukee & St. Paul Railway, read a paper on the "Quadruplex."

After a brief explanation of the apparatus, he referred to various applications which could be made besides its use between two stations. In their service they quadruplexed one wire between Chicago and Marion, Iowa, 225 miles, and worked a single wire from Marion to Omaha, 80 miles, into one side and another from Marion to Kansas City, 306 miles, into the other side. This enabled the Chicago office to work with any or all offices from Marion to Omaha inclusive. Another wire between Chicago and Milwaukee is quadruplexed. They work a single wire from Milwaukee to Minneapolis, 345 miles, on one side, and on the other side is worked a single wire from Milwaukee to Prairie du Chien, to Canton, South Dakota, 80 miles, during the night, and in the daytime this circuit is disconnected and that side of the quadruplex is worked duplex. With this arrangement at Milwaukee, they are enabled to close the night offices, allowing the wires to work through, giving the general office at Chicago access to the entire system through other night offices. With the aid of these combination and automatic repeaters at junction points they can, during the daytime, place their general manager's office in direct communication with any division superintendent's office on the system at very short notice. They run two wires from the telegraph office to the general manager's office; one to a key and sounder for transmitting, the other to a sounder for receiving; thence to ground, and with the aid of four switches they can extend the local circuits of either quad set down to his office on these two wires. The repeating sounder was placed on No. 2 side in search of trouble. They have now dispensed entirely with this sounder by putting the reading local circuit in place of the repeating local circuit on the neutral relay and allowing that relay to close the local on the back stop as before, then exchanging the tap wire and long end, which places the short end of battery to line with key closed. They give signal on back stroke at the distant end, and the whole battery to line with key open, breaking the local at the distant end. The change is found very beneficial in working single into quadruplex circuits where it is necessary to keep keys closed, so that when circuits are idle the short end is to line, preventing the heating of rheostat which otherwise would occur, and require continual watching. This he believed to be the proper and most economical way of operating a quad, because overcoming the danger of operators who worked on both quad and single wires from leaving single wire keys open. This change necessitated closing the key on quadruplex wires as well as single wires rendering the use of keys uniform. Mr. Fry also submitted a plan by which they expect to operate several quadruplex sets from one battery.

In the course of the discussion of Mr. Fry's paper, Mr. C. Selden described the events in connection with the first steps taken by Dr. Nicholson in the invention of his quadruplex in 1869, at Cincinnati.

Thursday, at 10 a. m., the Association visited and inspected officially the various exhibits of electrical apparatus, reference to which was made in our last issue.

Mr. J. W. UPP, of the Franklin Motor Works, Peabody, Mass., has joined the forces of the Thomson-Houston Co.

Letters to the Editor.

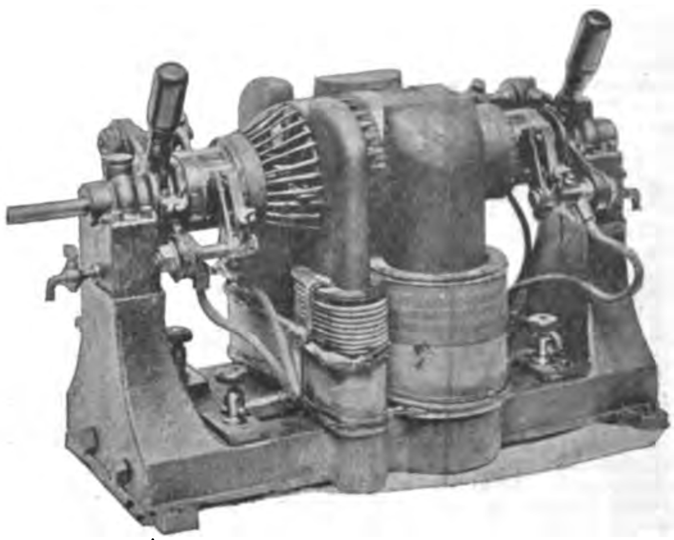
Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

CONSTANT CURRENT TRANSFORMERS.

In a recent number of *Engineering* under the title of "Lahmeyer Constant Current Transformer," there is described a machine now being exhibited at the Frankfort, Germany, Electrical Exhibition which is in all respects the same as one which I invented a considerable time ago. The peculiarity of my machine (and this peculiarity agrees with the Lahmeyer machine) is that one of the windings on the armature passes over a supplemental portion of the core influenced by a separate magnetic field in such a way as to cause a regulation for drop to take place.

My machine was designed and constructed for use in systems of distribution with continuous currents, and the machine is a continuous current transformer compounded for drop in the machine itself, for drop in the secondary, and for drop in the high



THOMSON'S CONSTANT CURRENT TRANSFORMER.

potential or main line leading to the machine. The machine also admits of ready compounding for the combined drop.

Such machines will readily enable a large station to be built, furnishing continuous currents which are transmitted to substations with the compounded transformers feeding local mains at low potential. The machines are efficient and require very little care in running. They may be compounded by the primary or the secondary current, or both, acting on the accessory field. The machines may also be made to use continuous currents for driving and produce alternating currents in the secondary system, or they may be run by alternating currents and produce continuous currents.

I herewith enclose a photograph of one of such machines (shown in the accompanying engraving) which I have had in use for a considerable time past. It is adapted to charge storage batteries at low potential by one of its windings, taking in current at comparatively high potential on the other winding. It will be seen that the field is divided into a large and small field magnet, the large one being energized in shunt and affecting both windings, while the small field is wound, in the present instance, differentially, and affects only one of the windings, in this case the low potential winding. The similarity of this machine to the Lahmeyer machine is evident.

I have worked out the principle in a variety of ways and of course it is impossible to say to whom priority belongs in this instance. It is another curious instance of the independent working out of the same invention by different workers in the field.

In this connection I may remark that the inventors here in the United States labor under a disadvantage as to publication which is not always present with foreign inventors. Our applications for patents in the United States require that a system of examination be had which often consumes months and sometimes years, especially if the inventor is strenuous in obtaining claims which are broad enough to cover his invention, and is not satisfied with the most limited claims, and especially, also, if the examiner, as is sometimes the case, makes renewed objections on technical grounds. The judgment of the courts has been that, should the United States applicant apply for foreign patents before the issue of his United States case his United States patents will be limited to expire with the date of the shortest foreign patent. He is therefore restrained from publishing any new invention or discovery at the time it is made, simply because if he does so he loses his rights to foreign patents; in accordance with the requirements of foreign countries that prior publication must defeat a patent. On the other hand, if he applies for foreign patents before his United States case issues, he must sacrifice so many years of the term of the United States patent as expresses the difference between the shortest term foreign patent and the seventeen years granted in the United States. It is within my knowledge that a considerable number of valuable electrical inventions which have been first published abroad have been made in the United States in the course of our more extended electrical work as a consequence of the conditions mentioned above.

ELIHU THOMSON.

LYNN, MASS.

HOW LIGHTNING DOES ITS WORK.

In Anderson's "Lightning Conductors," the Hotel de Ville at Brussels is referred to as being the building best protected against lightning of any in Europe, and the method of protection is described as the wire-cage system, which Professor Elihu Thomson points out as the most perfect in an article referred to in an editorial in THE ELECTRICAL ENGINEER of June 24. Unfortunately for Anderson and Professor Thomson, the Hotel de Ville at Brussels was damaged by lightning in the spring of 1888.

My system of lightning protection is based simply on experience. A dissipated conductor has never failed to protect, so far as I know, and, in this connection, I would state that Franklin made the same observation (see his letter to Peter Collinson, September, 1753), as did Wm. Watson, F. R. S. (see Vol. 52, p. 634, "Philosophical Transactions," 1761-62).

I can merely claim that I have put to use this physical law, which was at least partially enunciated by those old philosophers. I do not claim that my way is the only way of protecting buildings from lightning. I should not think, for instance, of suggesting the placing of one of my dispellers on a building largely made of metal; such a building can generally take care of itself. I do not claim that it is not an objection that the dissipation of my dispeller leaves the house for the time being unprotected, for this is too obvious to need mention, only suggesting that experience shows that houses (not ships) have been seldom, if ever struck twice in the same storm. I believe that I have added a new method of lightning protection to those already known, and that my method is based on experience—and not on *a priori* reasoning.

I agree with Prof. Thomson, in the main, in his ideas about the nature of lightning discharge and of the flash being the visible dissipation of the electrical energy as light and heat, but when he states that I do not consider the portion of the electrical energy dissipated in the air between the top of the house and the cloud, I can only think that he has not read my paper read before the American Institute of Electrical Engineers, April 21.

N. D. C. HODGES.

New York, June 26, 1891.

College Notes.

HARVARD ELECTRIC CLUB NOTES.

At the annual election of the Harvard Electric Club the following officers were chosen for 1891–92:—President, G. S. Curtis, '92; vice-president, C. H. Arnold, '92, and P. L. Spaulding, '92; secretary, T. Hopkin, '93; treasurer, H. C. Smith, '93; librarian, P. W. Davis, '93; members at large of executive committee, G. T. Page, '92; C. H. Arnold, '92, and H. Gregory, '92.

AUBURN COLLEGE, ALABAMA.

The Agricultural and Mechanical College of Alabama, at Auburn, will show its appreciation of the importance of electricity by establishing, this fall, an electrical department. Mr. A. F. McKissick, of Pittsburgh, and more recently of Cornell University, has been elected professor in charge of the new course. This institution at Auburn is one of the leading colleges in the South. It is situated in the iron regions near Birmingham, Decatur, Bessemer and Florence, and shares in every way in their modern and progressive spirit.

Metal and Supply Market.

THE INCANDESCENT LAMP MANUFACTURERS' ASSOCIATION.

The exclusive news published in THE ELECTRICAL ENGINEER last week as to the formation of the above Association was received with much interest by the whole electrical community, and has elicited much comment. The Association itself gave out no news, but refused to do so, and has denied all current reports as to its proceedings. On this point we have received the following from Mr. Otis K. Stuart, who was elected secretary:

"On page 716 of your issue of June 24 there is a notice of a meeting of the incandescent lamp manufacturers of this country, which was held at the Astor House, New York City, on Wednesday June 17th. There is hardly a statement in this notice which is correct, and either the party who gave you the information was not at the meeting or he has a very poor recollection of the results of the same. The officers who were elected at the meeting are permanent officers. As secretary and corresponding secretary of this Association, I feel authorized to state that any information not coming from me is unofficial, and I take this opportunity to so inform the electrical public. When we are ready to publish the results of our proceedings you will receive the proper official notification."

Whatever Mr. Stuart says "goes," but we can only say that our informant affirms the substantial accuracy of his statements and asks for a categorical contradiction of them.

To what was stated by us last week, it may be added that at the meeting to be held on July 17, a committee is to report as to the attitude and intentions of the lamp manufacturers still outside the Association; and there is much guessing as to the course to be taken by the Sawyer-Man, Thomson-Houston and Edison Companies. The first named has always strenously maintained the controlling nature of its patent, and its great licensee, the Thomson-Houston Co., has manufactured almost wholly for its own numerous sub-companies and isolated plants. Mr. Insull, who as second vice-president of the Edison General Co. is in charge of its manufacturing interests, says that the Edison patents have had hundreds of thousands of dollars spent on their legal supremacy, and that on no possible consideration would there be any change in the attitude of uncompromising hostility to infringers. It being suggested that probably the Edison lamp patents might now be adjudged as narrow or void, he replied, that even in that unlikely event the company would prefer to stand alone, and to follow the lines of active manufacturing competition that had kept it to the front for the past ten years.

It will be seen that the situation in the lamp industry, now growing so rapidly, is most interesting and critical.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of June 27, 1891, from New York, Boston and Washington:

NEW YORK.

	BID.		BID.
W. U. Tel. Co.	78⅝	Edison Gen. Elec. Co.	....
American Tele. & Cable	79	Edison Gen. Co. Def'd	....
Centl. & So. Amer	130	Consol'd Elec. Lt. Co	...
Mexican	200	Edison Illn'g Co. N. Y.	76
Com. Cable Co	104	U. S. Elec. Lt. Co.	30
Postal Tel. Cable	23	North Am. Phonograph	.. ..

BOSTON.

	BID.		BID.
Thomson-Houston	41¼	Ft. Wayne Co.	11⅞
" Pref'd	....	Am. Bell	....
" Series C	....	Erie	48
" " D	7	New England	50
" Int. Co.	....	Mexican	1.17½
Thomson Welding Co.	....	Trop. American	80
Thomson Eu. Welding	....	Edison Phon'gph Doll.	....

WASHINGTON.

	BID.		BID.
Penna. Telephone	24	U. S. Elec. Lt (Wash.)	155
Ches. & Pot. Telephone	62	Eck.&Sold. Home Elec.Ry.	49¼
Amer. Graphophone	5¼	Ge'rget'wn & Tennallyt'wn	57

Legal Notes.

EDISON INCANDESCENT LAMP LITIGATION.—IV.

ARGUMENT OF GEN. S. A. DUNCAN (CONTINUED).

The following morning, Tuesday, June 2, Mr. Betts resumed his argument as follows: He desired his Honor to take note of the Adams lamp of 1865, which seemed to him to be a very important step in the prior art. He thought that his brother Dyer in opening the case had visibly weakened when he came to the Adams lamp, and had run over it as gingerly as possible. Dr. Adams was a graduate of Harvard and a well-known inventor. As early as 1865 to 1869 he made a number of incandescent lamps with carbon conductors. He had applied the practical knowledge that he had as a manufacturer of Geissler tubes, to the making of incandescent lamps. His lamp had a carbon incandescent conductor, leading wires of platinum sealed into the glass, and an all-glass globe in which a high vacuum was maintained. It had contained everything described in the Edison patent, except the incandescent conductor of carbon was not of as small cross-section as that of Edison.

The complainants having substantially abandoned—he did not say in their argument, but the evidence of their experts had abandoned it—the two features of novelty relied upon in the English case, they now sought to rely upon a new feature; the supposed discovery by Edison of the stability of carbon in a vacuum.

Complainants' whole case stood on that position so far as any broad claim of novelty was concerned; everything else was old in the art. A comparison of Edison's platinum lamp with that of the patent in suit, showed that they were substantially alike, with the exception that in the platinum lamp there was a fine wire or filament of platinum, and in the lamp of the patent a wire or "filament"—so-called—of carbon. Now, was that Mr. Edison's discovery, that carbon was stable in a vacuum, and could he therefore claim that the substitution of carbon for platinum was an invention and involved discovery? He did not suppose it could be successfully contended that the attenuated form of the carbon had anything to do with its stability. It was not the attenuated form that made it less destructible; it was the fact that it was enclosed in a vacuum, and that there was no access of oxygen with its destructive action. His Honor would notice that there had been no hint of this supposed discovery in the English cases, and the plaintiffs' attempt to sustain the patent on that theory seemed to him to be due to a conviction that the basis on which the English case had proceeded was slipping from underneath them. Several of the prior patents had said that the vacuum should be made as high as possible; with the Sprengel pump a better vacuum could be obtained than with the appliances of earlier days, but the use of the earliest appliances had been just as much to render carbon stable, to the extent to which the vacuum had been produced, as in the most improved appliances of modern times. Mr. Edison had rather overstated the matter when he said he had discovered that carbon did not deteriorate at all. It did not deteriorate *as much* in a high vacuum as in a low vacuum, and yet Mr. Edison has stated in a later patent that there is a limit to a high vacuum beyond which one must not go. The same claim appeared to have been advanced in connection with the Sawyer and Man patent, but Mr. Justice Bradley in his finding in that case seemed to have disposed of that contention. If that discovery was as Mr. Justice Bradley says, not new, what was there left in the art to discover? A general statement that a carbon with small cross-section was the proper thing to use in incandescent lamps, did not advance the art; it did not tend to its preservation. What was needed was specific directions as to *how* to make and *out of what* to make an incandescent carbon conductor. The first man who had pointed out the particular kind of carbonaceous material, and how to carbonize it, could have made an invention and could have had a patent for a mode of producing carbon for use in incandescent lamps; but a mere general statement in reference to carbon in an attenuated form, or modes of preparing carbon which did not result in a commercially successful conductor did not advance the art at all. The world had not been taught how to select nor how to treat the incandescent conductor so as to make it a commercial success.

His Honor would find general statements in the patent, that Edison had "properly" carbonized cotton and linen threads, paper and wood splints. That had added nothing to the art. The thing was to know *how* to "properly" carbonize the proper materials. The tar-putty filament was the only one described in such detail that it could be followed with any accuracy. Mr. Batchelor, Mr. Edison's associate, had testified that there was nothing generally known in the art of carbonizing on January 9th, 1880 (long after the date of the application of this patent), which was now being used in a commercial Edison lamp. He had also testified that their methods of carbonization were known only to themselves. Now, unless the patent in suit had pointed out some method of carbonization which had taught the world what it did not know on January 9th, 1880, what had it added to the practical information of the public? Mr. Edison and the Edison Company were entitled to great credit for having made the bamboo lamp; so far as he knew, it was the first successful commercial lamp; but there was the distinct testimony of Mr. Batchelor that the merits found in the bamboo conductor did not exist at all in other fibrous materials. A similar contention had been passed upon by Mr. Justice Kay in the English case, in words which he thought were difficult to answer. He (the justice) says that it is somewhat difficult to make out that the lamps of the specification are commercially successful, if none were ever brought into the market, and that the success of the lamp made under a subsequent patent, like the bamboo lamp, which has been largely used, could hardly support a previous patent which had not described it.

On the construction which was sought to be made by the complainants, the claim, if constructed to cover any carbon of attenuated cross-section, was broad enough to include anything that had been done, but that was not what the art had needed. It needed a specific description how to make it, what to use, and what to select. There was another difference between the English cases and the present case, and that was the proof in this case, that a peculiar method of carbonization was necessary to the making of a practically successful lamp, namely, electrical carbonization in a vacuum. The specification did not give—whether it was an intentional suppression or whether Edison did not know it—that description of the way of making a commercially successful lamp.

(Mr. Duncan observed that Mr. Edison had testified that in the very first lamp he made in 1879 he used the process of carbonization described by him which included electrical carbonization on the pump.)

Mr. Betts said that besides those general statements that were to be found in the patent in suit, they were confronted by another difficulty, and that was that Edison had been practically anticipated in those general statements. His Honor would find a stipulation as to the date of publication of copies of the Lane-Fox patents. That was important, because one of these patents was relied upon as a printed publication. The stipulation gives the date of October 18, 1879, as the date when it had been published and put on sale; that was three days before Edison claims to have made his invention. It was a very narrow margin, but he supposed three days was as good as three years. Mr. Betts then read a number of extracts from the patents and publications of Lane-Fox, which he contended anticipated Edison in pointing out that an incandescent lamp could be made of a carbon conductor of high resistance, and of small radiating surface, enclosed in an all-glass vacuum chamber.

He would submit, therefore, that the result of all these inquiries was, that the present invention ought to be limited to the specific thing made as described, and not extended to all successful carbon conductors. Such a view was in harmony with the final decision of the German court, and in harmony also with the position the Edison Company had taken in connection with their other pending application. They had maintained for years the position that the patent in suit did not claim broadly what it was now asserted to claim, but that the broad invention had been contained in another application. He submitted that these views were sufficient to satisfy the defendants that the patent should not have the construction which had been contended for.

ARGUMENT OF MR. EDMUND WETMORE FOR THE UNITED STATES ELECTRIC LIGHTING COMPANY.

Mr. Wetmore said that in closing the argument for the defendant, he should only endeavor, very briefly, to recapitulate the principal points which were relied upon to support the proposition, that under the legal construction of the patent involved in the suit the defendants had not infringed it. To this end he should recall some of the leading facts in the prior state of the art and should once more ask his Honor to take a final inspection of the language of the specification, in view of all the facts elicited during this long discussion. Referring to the prior state of the art, they had two facts to start with:—first, that the date of the invention in this case had been fixed beyond controversy on October 21, 1879. Upon that date, and not until that date, did Mr. Edison first put a carbon conductor, claimed to fall within the terms of this patent, into a hermetically sealed globe; and upon that date and not until that date, by his own testimony, does he allege that he discovered the fact of the high degree of stability which that conductor possessed under those conditions; a discovery which had been urged by his friends on the other side as the very gist of the invention. The other fact was that the invention or discovery disclosed in Mr. Edison's American platinum patent had passed into the prior state of the art. That had been established beyond contradiction, first by the fact that a French patent containing the description of the alleged discovery, in the fullest possible terms, had been issued before the invention in suit had been made, and second, that it was the law established by authorities that he need not stop to cite, that when a patentee had described in a patent a broad invention and had claimed it, or not claimed it, he cannot make that invention the subject of a subsequent patent, unless at the time of applying for his first patent he had either announced his intention to do so on the face of the instrument, or had accompanied it by an application for a broad claim in another patent. Neither had taken place in this case.

Mr. Wetmore said he would next refer to some of the general facts which had been brought forward in regard to the prior state of the art. He then entered at some length into a discussion of the technical considerations involved in the distinction between lighting in multiple arc and lighting in series, which is omitted as not being necessary to the understanding of his argument. In the course of this explanation Mr. Wetmore showed conclusively that multiple-arc lighting, though a large and important branch of electric lighting, was not the whole of it and never had been. Hence, he said, the man who discovered the proper way of making a lamp for multiple arc lighting did not solve the whole problem, though he solved the most important part of it; and moreover, he might say that the problem, so-called, of house-to-house lighting had not yet been solved. With all the inventions and improvement that have been brought to bear, it could not yet be produced cheaply enough to supply the place of gas in the ordinary household. He said this, not in the slightest to depreciate the value of the discovery, whoever made it, of the use of high resistance lamps in multiple arc. It was a discovery of very great value, but for reasons which have already been stated to his Honor, the defendants' position was that it was absolutely and utterly out of this case. Mr. Edison may have been first; Lane-Fox may have been first. He hoped it was Mr. Edison, because he was an American; he was entitled to whatever credit belonged to him; he had claimed that credit in his earlier patents; there let his claim rest. The subject-matter of the present controversy did not depend upon the value, or character, or even the existence of that discovery, except so far as the patent might be an improvement upon the means of lighting which that discovery gave.

Before leaving this subject he would call attention once more to the first claim of the platinum patent:—

"In an electric light, the combination with a hermetically sealed vacuum chamber made entirely of glass, of metallic conductors passing through the glass, and an incandescent conductor placed in an electric circuit, substantially as set forth."

The word *metallic*, originally in the claim, had been stricken out by Mr. Edison, so that he might stand on that broad claim of a conductor *of any material*, having the properties of high resistance, enclosure in a vacuum and means to enable it to be used in multiple arc. He would recall a few of the facts that were known at the date of Mr. Edison's invention here in controversy. It was known that the resistance of a conductor depended, first upon its specific resistance and second upon its shape; now, as to the materials of which those conductors could be made, and indeed, up to the present time, there were substantially but two materials known in the world; one was platinum and the other carbon, and carbon had been recognized for years as the superior material because of its high infusibility. It was known that carbon was the most stable material in nature; if a stable conductor could not be got with carbon it could not be got with anything in the universe; that was the reason carbon had been used in all the early lamps.

His friends upon the other side had contended that the Adams lamp was an abandoned experiment; it was in fact merely a premature invention; he had referred to it merely as showing a striking instance of the fact that it was known to those who worked at such apparatus, that a conductor of extreme tenuity could be enclosed in a vacuum, carrying the current to it by platinum wires, and that it had a high degree of stability. Here was an instance where a man, a worker in the art, had actually applied it.

After recapitulating at some length Edison's course of experimentation with platinum and carbon, as shown in the evidence, Mr. Wetmore said that in regard to the efficiency of the platinum wire as compared with that of the lamp of the patent, Mr. Edison himself had given important testimony. In a paper read before the American Association at Saratoga, after he had made the platinum lamp, Edison had stated that he had obtained eight 16-candle lights per horse-power, while in the tests made by Rowland and Barker on the lamp in suit, it appeared that its value was only about six lamps per horse power. Mr. Clarke had testified that the efficiency of the carbon lamp of the patent was about eight per horse-power; in other words, the efficiencies of the two lamps were practically the same. It was perfectly true that the platinum lamp did not go into commercial use, but neither did that of the patent. They were both superseded by a lamp which was cheaper, better and more available for the purposes of the market. If he apprehended the argument of the complainants, the invention claimed was the discovery that carbon, reduced to the attenuated form necessary to give it high resistance, had stability enough to make it practically useful in an incandescent light. Upon that discovery, and upon that alone, must they base their claim for a broad interpretation of this patent. It was worth while to consider that contention more closely; first, it could not be claimed that stability was not a known property of carbon; it was not only a known property but was its characteristic and best known property. It was also known, and indeed was a matter of necessary inference, that the more thoroughly the destructive gases were removed from the bulb, other things being equal, the longer would be the life of the carbon; such being the fact, as he understood the law, it could not make any difference whether anybody by actual trial had ascertained to precisely what point of tenuity a carbon conductor could be carried. It was merely a question of degree. Everybody knew for example, that if a hempen rope were run over a metal pulley, it would be worn out by friction; and a slender rope would be worn out more quickly than a thick one; everybody knew that by reducing friction, the rope, whether thick or thin, would last longer than it would otherwise; but if a man by the ordinary methods of removing friction, got a pulley over which he could run a more slender rope that he thought he could—use a filamentary rope, in fact—he had discovered a new property in ropes, he had made an invention. Mr. Wetmore then cited the decision of the Supreme Court in the case of the *Comminuted Glue Company* vs. *Upton*, to show that complainants could not stand upon the alleged discovery that carbon had a high degree of stability, but that they must go a step further in order to enter the field of invention; that was what Mr. Edison had done in this patent and had got a patent for. It might have been an invention to so carbonize the carbon as to give it a very high specific resistance. Another point was the making of the spiral. In short Mr. Edison could only have a patent for his method of manufacturing that particular carbon, so as to have one that could be practically used in an incandescent lamp.

Mr. Wetmore then proceeded to read the statement of invention as set forth in the preamble of the Edison patent, and observed that the statement of the prior state of the art was incorrect because it ignored much that was known, as for example the King lamp. The reversal of the previous practice of inventors, referred to in the patent, and upon which much stress had been laid, was inaccurate and misleading, because the reversing of that process was in fact, not what was contained in this patent, but what had already been given to the world in his preceding patent. The remainder of the patent was ill drawn, because that instead of containing explicit directions, so that a person skilled in the art could follow it, it consisted of a number of disjointed statements of what Mr. Edison had discovered, the whole making a description, defective, if any person wanted to carry it out; but to show what had been intended to be covered by the patent the description was intelligent enough. The discovery that cotton thread properly carbonized will give a very high resistance was not a discovery because it depends upon the length the thread which is cut off. Mr. Wetmore then proceeded to make a detailed analysis sentence by sentence of the specification and claims, and in summing up his conclusions, said that however indefinite the term "filament" might be as designating any particular length or any particular degree of fineness, it did give a definite claim in reference to the body of the specification, if it had the meaning which he insisted upon that it did have, to wit:—a piece of fine high resistance carbon, coiled into the spiral conductor of the patent. Whether or not there was any invention, in view of the prior platinum patent, in adopting this form, Mr. Edison had chosen to make it essential by his description. He could not come in now and say, "Here I have described a conductor of a particular sort; one of its characteristics is that its radiating surface is reduced to three-sixteenths of an inch instead of the whole surface," and then say to a man—"Well you don't use that; you have got a conductor in which you use the whole amount of radiating surface, and I don't consider that which I said was so essential, after all, to be of any importance."

In that connection he wished to state his position in regard to those most significant admissions that had been made in the divisional application which had been pressed by the plaintiffs. They had gone into the Patent Office, after this patent had been granted, and asked that another patent be given to them on the ground that the one here in suit was expressly limited to the very construction for which he (Mr. Wetmore) had contended. Now if their present construction of the patent was right, they could not have that claim, because the conductor sought to be patented was precisely the one which they here claimed to be an infringement of the patent in suit. If the patent which they are now seeking should be granted, and if their construction of the present patent was correct, the former would be absolutely void. They were endeavoring to pursue this suit and to pursue that application; these were inconsistent grounds. If they lost this suit they would have a patent, and if they won the suit they would not need it. It appeared to him that a party could not be heard, in a court of equity, to take those inconsistent positions.

Mr. Wetmore said he would refer to one more point, and that was the extreme injustice on the part of the plaintiffs, in view of the facts, in making the almost appalling claim which they had based upon this specification. The defendant, as appears from the record, had been in this business since early in 1880; the first incandescent lights which appeared in the city of New York, had been put up by that company, in the Equitable Building. A million and a half of dollars had been put into the business; they had sold over 36,000 lamps the first year; they had gone on rapidly increasing until they were now selling more than a million per annum. They had pursued that course for five years, right under the nose of the Edison Company, and during the whole of that time they had certainly never heard anything of such a claim as had been presented in this suit. The only explanation of that five year's delay was to be found in what the plaintiffs had been seeking to obtain in the Patent Office on that pending application, and they had never been able to offer any other possible solution of the question. Finally when they found that that was their best chance, they had unmasked this battery and said, "Here is the claim on which we seek to embrace the whole of this field." They had taken the cork out of this narrow bottle, and the afrite had come out of it, like the character in the Arabian Nights. Could these plaintiffs be entitled to this discovery, and to uphold that patent upon that broad theory against $20,000,000 of capital invested in the Thomson-Houston and in the Westinghouse companies, and ask the court to prohibit the sale of these lamps by all these establishments; so that it would wreck private fortunes; so that it would depreciate stock to the extent of millions; so that it would throw large corporations into bankruptcy; and if they were right, they could have the full power of this court extended to throw into the hands of this single company a monopoly so vast, that in any other country except one with an all-abiding sense of law, the result would be a revolution. That was their position, and they say now after the language of that specification which he had word by word read to his Honor:—"We ask the court to construe that, against our own solemn admissions," more broadly than any of the famed electricians within the sound of his voice would ever think of construing it, and they are the parties to whom it was addressed. He did not believe that their claim was well founded, and in that belief, he should leave the defendants' rights and the protection of the public as well, with the utmost confidence, in the wisdom and experience of his Honor.

(Here the court adjourned for the day.)

SUIT ON FIXTURE PATENTS.

A suit has been commenced by Mr. George Maitland, owner of alleged controlling patents on electric and combination gas and electric fixtures, through his counsel, Messrs. Philipp, Munson, Phelps & Hovey, of this city, in the United States Circuit Court at Philadelphia, against Alfred C. Gibson, doing business as the Gibson Gas Fixture Works, of Philadelphia, Pa. Mr. Gibson has appeared through his counsel, Theodore F. Jenkins.

Reports of Companies.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

The adjourned meeting of this company was held at Pittsburgh last week, June 23, but was again adjourned until July 15, in order that further assents of stockholders to the scheme of reorganization might be secured. It is understood that nearly 100,000 shares have now assented, leaving but a few thousand shares to come in. The time for assenting is limited to July 8.

DIVIDENDS.

THE COMMERCIAL CABLE CO. have declared a quarterly dividend of 1¾ per cent., payable to shareholders of record on June 20.

THE THOMSON-HOUSTON CO. have declared a dividend of 87½ cents (3½ per cent.) per share on the preferred stock to stockholders of record June 23.

MOUNT VERNON, CONN.—The Mount Vernon Electric Light Co. has declared a quarterly dividend of 1½ per cent.

ELECTIONS.

MILFORD, MASS.—The Milford Electric Light Co. has elected G. M. Greene president and treasurer and A. S. Trowbridge, clerk. The annual report showed net earnings of about $1,000. The company is to look into the subject of storage-battery lighting for houses and factories.

Obituary.

THEO. LARBIG.

The death occurred last Saturday, in Brooklyn, of Mr. Theo. Larbig, who was shot by Mr. J. V. Meserole, son of the City Surveyor, during a quarrel. Mr. Larbig was well known in electrical trade circles from his long and active connection with the supply business.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JUNE 23, 1891.

Accumulators:—

Electrode for Secondary Batteries, B. Anderson, 454,818. Filed Sept. 29 1890.

Electrode formed of two perforated plates, each having transverse flanges on three edges; corresponding flanges on the plates are secured together to unite them, leaving a central recess open at top to receive active material.

Alarms and Signals:—

Electric Signal-Receiving Instrument, G. L. Foote and W. C. Moore, 454,643. Filed April 14, 1891.

Relates to the class of signals known as "individual call apparatus" for central station service.

Electrical Fire-Alarm, B. W. Leonard, 454,746. Filed March 24, 1891.

A thermostat with a system of circuits and electro-magnetic apparatus for sounding an alarm in a building and in stations of the fire department.

Conductors, Conduits and Insulators:—

Electric Conductor, A. W. Sperry, 454,546. Filed Oct. 27, 1890.

Metallic conductors have tubular ends and plugs to unite one length to the next together with a fire and water-proof covering.

Insulating Material, A. W. Sperry, 454,547. Filed Oct 27, 1890.

Composed of mineral wool and silicate of soda or potash and zinc white.

Compound for the Manufacture of Insulators, Packings, etc., A. W. Sperry, 454,548. Filed Dec. 22, 1890.

Consists of mineral wool, rubber, linseed oil and oxide of iron; in about the proportions of eight pounds of mineral wool, one and one-half pounds of rubber and linseed oil combined, and three pounds of oxide of zinc.

Electric Connection, J. H. Bickford, 454,794. Filed March 6, 1891.

An improved bond or electric connection for joining the rails of a track intended to be used as a conductor.

Distribution:—

Electric Regulator for Constant Potential, C. Hering, 454,475. Filed Dec. 16, 1887.

A rheostatic device actuated by electro-magnetic apparatus. The rheostat acts upon the principle of pressure upon a series of carbon discs or plates to diminish their resistance.

Electric Regulator for Constant Potential, C. Hering, 454,476. Filed May 24, 1889.

Amplification and an improvement on the invention shown in No. 454,475 above.

Regulating Electric Lights and Power, I. and A. Hersberg, 454,650. Filed Dec. 10, 1890.

Relates to apparatus for controlling the length of time during which an electric circuit is held open or closed.

Dynamos and Motors:—

Belt-Controller for Dynamos, W. A. Foote, 454,467. Filed July 31, 1890.

Commutator for Dynamos or Motors, C. A. Lieb, 454,488. Filed Dec. 12, 1890.

Consists in making the commutator sections of aluminum or of an aluminum-alloy; also includes details of construction.

Speed-Regulator for Dynamo-Electric Machines, E. E. Winkley, 454,541. Filed Apr. 15, 1890.

Relates to electro-magnetic devices for controlling the valve-action of the engine or other original source of power.

Electric Motor, F. B. Rae, 454,626. Filed Sept. 5, 1890.

An automatic switch, especially adapted to shunt-wound machines, operating to break contact between the main line and motor in the event of interruption or variation in the circuit.

Electric Motor, A. B. Roney, 454,627. Filed Jan. 3, 1891.

Has one or more auxiliary motors rotating radially around a common axis and means for adjusting such auxiliary motors from the centre to change the speed of the main shaft.

Galvanic and Thermo-Electric Batteries:—

Galvanic Battery, P. Hathaway, 454,598. Filed Sept. 18, 1890.

A chloride of silver battery. A zinc vessel contains the negative element and the exciting fluid and also forms the positive element; the negative element of chloride of silver is in the form of a rod having an indented or corrugated suface.

Galvanic Battery, J. Emmner, Jr., 454,794. Filed Dec. 15, 1890.

Relates to batteries of the Bunsen type. The element outside the porous cup is composed of a series of horizontal plates or sections sufficiently separated from each other to permit a free circulation of the fluid.

Lamps and Appurtenances:—

Electric Arc-Lamp, H. Lemp & M. J. Wightman, 454,485. Filed Oct. 26, 18?6.

Relates to the class of lamps in which the regulating mechanism is under the sole control of a shunt magnet during the normal action of the lamp. The present invention employs the main-circuit magnet to form the arc, after which operation it no longer acts in the operation of the lamp.

Incandescent Electric Lamp, T. A. Edison, 454,558. Filed Aug. 7, 1882.

A conducting wire, passing through the globe socket, is joined to the loop filament, midway of its length, by which arrangement the carbon filament may be used in the ordinary manner or as two conductors in multiple arc; or either half may be used by itself.

Electric Search-Light, G. Sautter, 454,604. Filed Feb. 27, 1891.

Relates particularly to mechanism for directing search-lights from a distance by electrical means.

Lamp Cut-Out and System, E. Thomson, 454,782. Filed Mar. 20, 1886.

Relates to the operation of incandescent lamps in series, and provides for the establishment of a shunt or short-circuit around a lamp upon the interruption of the series circuit by the rupture of a filament.

System of Electric Lighting, N. Tesla, 454,622. Filed Apr. 25, 1891.

Consists, chiefly, in generating, for the operation of lighting devices, currents of enormous frequency and excessively high potential. Employs induction apparatus for transferring such currents to a working circuit. Includes the charging of a condenser and the maintenance of an intermittent or oscillatory discharge of such condenser through or into a primary circuit, to which the secondary or working circuit is in inductiv

Produces incandescent light by connecting a conductor inclosed in a rarefied or exhausted receiver to one only of the poles of a source of electric energy of high frequency and high potential.

Electric-Light Hanger, G. W. Smith, 454,815. Filed Jan. 22, 1891.
For the suspension of arc lamps; includes means for disconnecting so as to keep the circuit closed while the lamp is disconnected.

Medical and Surgical:—

Electrical Pessary, W. N. Sherman, 454,573. Filed Feb. 18, 1891.

Miscellaneous:—

Electric Elevator, R. Eickemeyer, 454,462. Filed May 14, 1890.
Electro-mechanical means, in the control of the elevator attendant, to regulate or reverse the motive power.

Limit-Switch, F. B. Rae, 454,496. Filed Jan. 14, 1890.
For application between a generator and translating devices; adapted to operate when the strength of passing current reaches a dangerous point; automatic in action.

Magnetic Separator for Paper Pulp, C. H. Atkins, 454,555. Filed Aug. 11, 1890.
Improvement upon the invention patented to the same inventor Nov. 27, 1888, No. 393,348.

Walking Automaton, G. R. Moore, 454,570. Filed Jan. 30, 1891.

Switch-Board for Telegraph Lines, F. T. Viles and M. Young, 454,584. Filed Jan. 13, 1891.

Electric Hose-Coupling, J. B. Strauss. 454,669. Filed Mar. 19. 1891.

Lightning Arrester, E. Thomson, 454,671. Filed Oct. 30. 1890.
Claim 1 follows:
The combination, with an electric-line circuit including an apparatus to be protected, of a lightning-discharge path from the line-circuit, shunting such apparatus and electro-responsive means respectively in such line-circuit and shunt and arranged in inductive relation to one another, so that the passage of the discharge through the shunt means generates a counter electromotive force in the line circuit means, opposing the passage of the discharge through the aforesaid apparatus to be protected.

Lightning-Arrester, E. Thomson, 454,672. Filed Nov. 5, 1890.
A lightning-arrester comprising a pair of discharge-plates, a number of sets of polarizing-cells in series therewith, and a plurality of discharge-plates with jumping-spaces in shunt with the sets of polarizing-cells.

Lightning-Arrester, E Thomson. 454,673. Filed Jan. 31. 1891.
Improvements upon the apparatus described in patent 454,671 above.

Method of and Apparatus for Heating Bars by Electricity, E. E. Angell, 454,698. Filed Mar. 16, 1891.
Consists in inserting a bar or blank in an electric circuit, then inserting another in parallel in the same circuit, side by side with the first, and then withdrawing one from the circuit, the other remaining in circuit during the withdrawal of the first.

Insulator for Marine Condensers, P. Decker, 454,717. Filed Feb. 5, 1891.
Seeks to obviate the galvanic action caused between the copper tubes and the iron parts about the keel of a vessel in the method of condensing frequently employed, by interposing a complete non-conductor of electricity between the adjacent portions of the exhaust steam-pipe and the copper condensing tube.

Electric Circuit Closer, J. H. R. Ward, 454,816. Filed Jan 8, 1891.
A circuit closer of the class operated by a suspended cord or chain.

Electro-Magnetic Clutch, E. S. Bennett & H. F. Parshall, 454,832. Filed July 29, 1890.
Employs electro-magnetic attraction to arrest motion, as a brake, or to transmit motion.

Railways and Appliances:—

Brake Mechanism for Street Cars, N. C. Bassett, 454,450. Filed Dec. 29, 1890.
The gearing is so arranged that the tractive power upon the different axles is rendered unequal; means are provided for changing at will the leverages by which the braking power is applied to different wheels so as to keep the braking pressure proportioned with their unequal tractive effects.

Overhead Electric System, C. A. Lieb, 454,486. Filed Nov. 6. 1890.
Relates to the suspension of trolley wires, and consists in the use of springs for keeping the wires at the proper tension automatically.

Car-House Hanger, C. A. Lieb, 454,487. Filed Nov. 18, 1890.
For the attachment of trolley wires to the ceiling.

Trolley-Pole Mechanism, G. H. Larkin and J. Tomkins, 454,522. Filed Feb. 17, 1891.
Relates to mechanism for supporting and controlling trolley rods.

Trolley for Railway-Cars, E. Verstraete, 454,582. Filed July 26, 1890.
Relates to trolley arm and support.

Electric-Car Trolley, W. Duncan. 454,536. Filed June 25, 1890.
Means for balancing trolley poles.

Electric Signal for Railway Trains, F. P. Lenahan, 454,625. Filed Feb. 28, 1891.
Relates to signals for giving warning of the near approach to each other of railway trains upon the same track.

Telegraphs:—

Telegraphy, B. B. Toye, 454,630. Filed Sept. 25, 1890.
Relates to improvements in duplex, quadruplex and sextuplex telegraphs, particularly to the latter.

Telephones and Apparatus:—

Signal Device for Telephone Pay-Stations, W. Gray, 454,470. Filed Apr. 19, 1890.

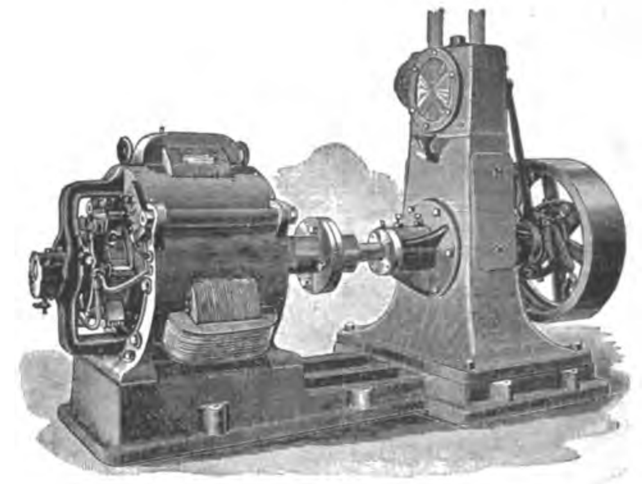
Signal Attachment for Telephones, A. D. Sundeen, S. B. Molander, G. W. Anderson and A. M. Carlsen, 454,503. Filed June 23, 1890.
Devices intended to enable automatic responses from a telephone, in the absence of the operator, signifying that no one is present to reply and when the absent operator will return.

Signal Attachment for Telephones, A. D. Sundeen, S. B. Molander, G. W. Anderson and A. M. Carlsen, 454,504. Filed June 23, 1890.
Similar in purpose to the above, includes a phonograph in connection with a telephone.

MR. CHAS. T. LINDNER, who was formerly connected with Edison interests in New York and more lately with the Edison General Electric Co. in San Francisco has now opened an office at Room 5, No. 316 Pine street, San Francisco, as a consulting electrical engineer.

THE ELEKTRON LIGHTING PLANT ON BOARD THE STEAM YACHT "ROMOLA."

THE accompanying engraving shows the plant recently installed by the Elektron Manufacturing Co., of Brooklyn, N. Y., on the steam yacht "Romola," belonging to Mr. Joseph Pulitzer, proprietor of the New York *World*. The dynamo is an eighty-five light slow-speed Perret machine of the usual construction, waterproofed, and is coupled by a flange coupling to the shaft of a Case steam engine, running 585 revolutions per minute. The combination is placed on a substantial bracket in the side of the engine room, and runs without any appreciable vibration. The yacht, which is 170 feet long, is well lighted by the dynamo direct in the evening,



PERRET SLOW SPEED DYNAMO ON BOARD THE YACHT "ROMOLA."

and by storage batteries during the day-time and when the dynamo is not running.

Where it is desirable to be very economical in floor space, a different style of coupling is used by the Elektron Manufacturing Co., and the space between engine and dynamo shortened up considerably.

AUTOMATON PIANO CO.

A reception was given at the Hotel Brunswick on Thursday, the 25th, by Mr. A. B. de Freece on behalf of the directors of the Automaton Piano Company, and several well-known people were present. The rendering of the various compositions clearly demonstrated the fact that it is possible to produce by a mechanical means all the expression and effect of an accomplished musician. The automaton is an attachment placed on an ordinary piano and run by the means of machinery. In the case of this reception the machinery was run by a C. & C. motor connected to Gibson storage batteries. The attachment does not in any way alter the appearance of the piano, as it is placed out of sight. A roll of perforated music was inserted, the drawer closed, a button was touched, the keys suddenly moved as if touched by an invisible hand and the piano commenced playing Wagner's "Tannhauser," bringing out perfectly the grand melody and full tone of the Steinway piano to which the automaton was attached. The whole affair passed off very pleasantly under the direction of Mr. de Freece, who is well known to the electrical people as having had charge of the Edison exhibit given at the Lenox Lyceum some time ago.

BISHOP GUTTA-PERCHA CO.

After a hard fight, the Bishop Gutta-Percha Co. has, Mr. H. A. Reed informs us, succeeded in convincing some people that good work pays, even though it costs money. The result is the market for their product is an ever widening one. Since January last they have sent to Washington nearly 30 miles of underground cable, over 3 miles of it being equal to No. 00. They have made for the Narragansett Electric Light Co., of Providence, six No. 0 and two No. 6 armored cables to carry the current under the river. They are now making about 10 miles of underground cable, mostly large conductors for incandescent work, for the West End Electric Co., Philadelphia. Another order is for an armored cable, equal to No. 0, and 7,000 feet long, to carry high potential alternating current across the bay at Tacoma, Washington. This cable will weigh about 20,000 lbs., making a full carload.

MR. W. W. COLE is the new superintendent of the Utica Belt Line Street Railroad Co.

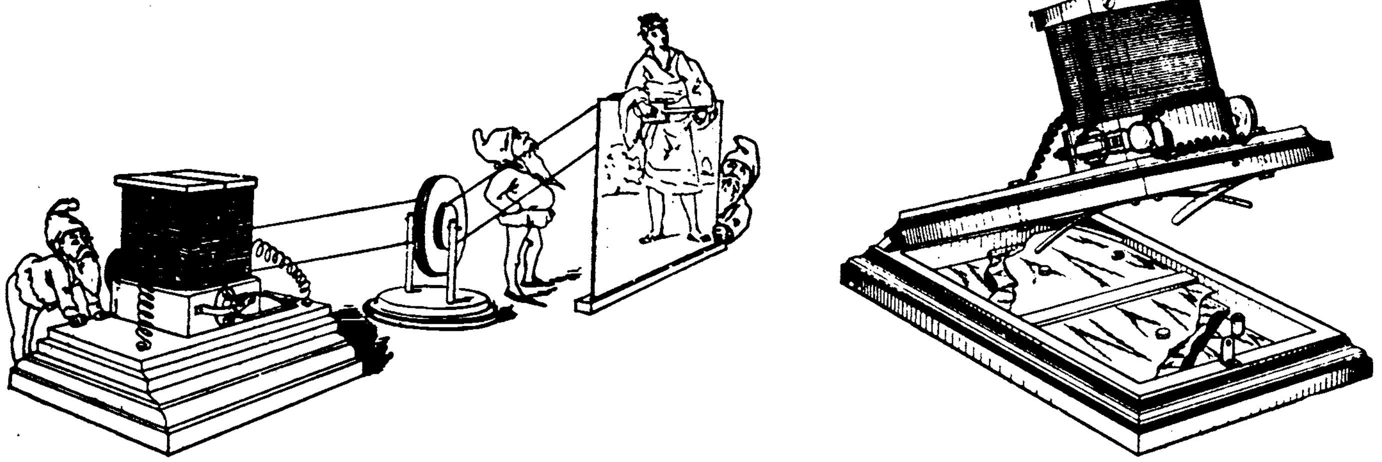
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

In adverti‸ing, familiarity with the name leads to familiarity with the goods.

THE SIMPLEX ELECTRIC ENGINE.

ELECTRICITY in all its branches has long been a most fascinating study to the boy-student, but since the almost universal adoption of electricity for furnishing light and power, it has become



FIGS. 1 AND 2.—THE SIMPLEX ELECTRIC ENGINE.

a veritable necessity to furnish him with some cheap piece of electrical apparatus which he can operate himself, and from which he can learn the principles of the larger forms of dynamos and motors. Recognizing this fact, and aware that there was no perfect toy motor in the market, Mr. L. H. Rogers, well known to the

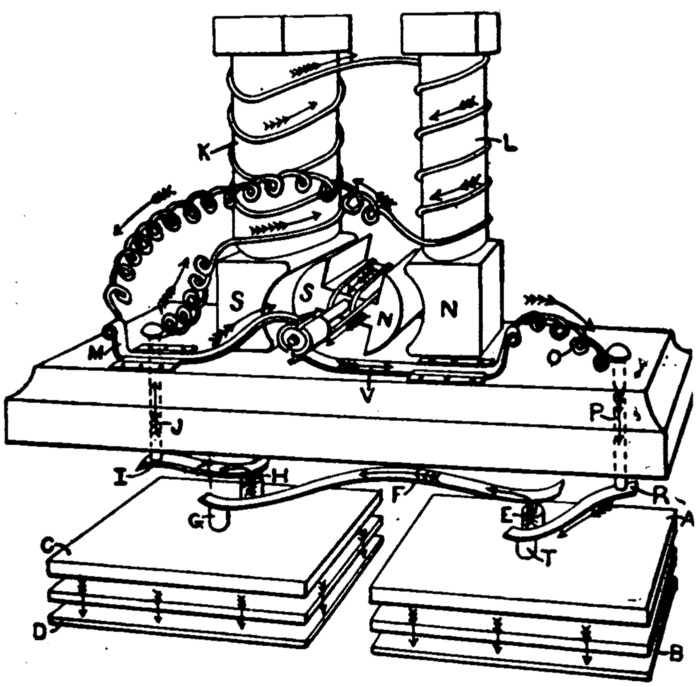


FIG. 3.—THE SIMPLEX ELECTRIC ENGINE.

electrical fraternity in the East, set himself to design a toy motor which would meet the requirements, be built on thoroughly sound electrical principles, be at the same time lasting, and yet be so cheap as to be within the reach of every boy in the land. After a long series of experiments Mr. Rogers at last designed the Simplex electric engine, which we illustrate herewith, and which is composed principally of two parts, the motor and the battery.

The engraving, Fig. 1, shows the general appearance of the engine, as furnished, driving a small mechanical toy, such as the "Wandering Minstrel." The motor itself is composed of two soft iron field magnets, with a simple Siemens armature, and the method of winding is well shown in Fig. 3, showing also the general direction of the current. The motor is fastened to a wooden frame, which is hinged to the wooden base forming the receptacle for the battery elements, as shown in Fig. 2.

The base is divided into two partitions, so that there are really two cells in series, the connections being made by the springs underneath the motor frame. The elements of the battery are arranged as follows: In the bottom of the receptacle is placed a piece of sheet copper, and at the top a piece of sheet zinc. Between the two is a little pad made of three sheets of blotting paper with powdered sulphate of copper between the lowest sheet and the upper two, and stitched at the edges. On top of the zinc a small stud is riveted in to form a contact for the spring, and a similar stud projects through an insulated ring in the zinc from the copper so as to give contact on the copper terminal. The battery is then moistened with a little water, and when the motor is hinged down it is ready for operation.

The motor runs at about 1,500 revolutions per minute for about six hours, and the battery can easily be replenished by keeping a supply of the battery pads.

The greatest attention has been paid to the most minute details and the motor and battery are complete in every way. The commutator is perfect, and the brushes can be shifted by a small attachment, just as in an ordinary commercial motor. Mr. Rogers has written a very complete and interesting pamphlet which goes with the engine, and which is a thoroughly scientific, but simple, explanation of the laws embodied in producing motion from an electric motor. The motor, its windings, and some of its details are all patented, and the sale has been something unprecedented, thirty weekly newspapers having offered it as a premium.

The Electro Novelty Company, of 9 Knapp street, Boston, are manufacturing these engines, and have a most complete machine shop, capable of manufacturing 1,000 a day. The engine and pamphlet complete with toy sells for $1.25, and we would cheerfully recommend one for every boy studying electricity, as a source of infinite amusement and considerable education.

THE EDISON MINING LOCOMOTIVE.

The Edison General Electric Co. have issued a very neat 18 page circular descriptive of their various styles of electric locomotives for mining and mill work, recently illustrated in THE ELECTRICAL ENGINEER. In addition to this, the circular contains an interesting little essay on "Underground Haulage by Electric Power."

CENTRAL ELECTRIC CO.

The Central Electric Company are receiving some very large orders for extra sizes of Okonite wire, and have recently taken several contracts for this wire, running as high as 600,000 circular mills in diameter. As the most of this is for underground and submarine work, it is evident the large purchasers are beginning to realize that the best is always the cheapest.

QUEEN'S NEW BUNSEN PHOTOMETER.

We are informed by Queen & Co., of Philadelphia, that a large standard photometer designed for the measurement of incandescent lamps has recently been made by them for the Standard Lamp Co., Appleton Wis. This photometer differs from the large ones previously made, in that it has special attachments for holding and testing the lamps, which enable the work to be done rapidly as well as accurately. The instrument may be briefly described as follows:—Two tables about four feet high (with drawers in them for accessories) support the standard bar, which is made of brass, 500 centimeters long and graduated in 1000 equal parts. The left-hand table carries a sensitive candle balance arranged for weighing the candle while in use. A standard Methvin burner is furnished in addition, which gives a uniform gas flame, which has been found much more reliable than the candle flame. On the right-hand table is a special-lamp holder, which can be rotated so as to present any part of the lamp to the sight box. This holder is extremely convenient, as it is only necessary to insert the lamp in the socket when a test is made, all connections being from below. A sight box on wheels moves along the bar and curtains are provided to shut out all light, except from the standard and the lamp under test.

A USEFUL COMBINATION TOOL.

The accompanying illustration represents a combination plier manufactured by the Cincinnati Tool Co., of Cincinnati, O. This little tool is exceptionally strong, and is a veritable case of *multum*

THE CINCINNATI TOOL CO.'S COMBINATION PLIERS.

in parvo, including, as it does, a large and a small screwdriver, one on either handle, a pipe wrench, and two wire cutters of different sizes, besides performing the function of the ordinary lineman's pliers. Its convenience and great strength are sure to recommend it to those engaged in construction work.

THE BALL & WOOD SHOPS.

The new machine shop for The Ball & Wood Co., at Elizabethport, N. J., is fast approaching completion. The building is made of brick and iron, designed and built by The Berlin Iron Bridge Co., of East Berlin. Conn., and will be used by The Ball & Wood Co. for a machine shop. The central portion is 40 ft. wide with a wing on each side 20 ft. wide, the entire central portion of the building being served by a traveling crane driven by electricity.

This promises to be one of the most complete machine shops in the Eastern States.

PARMLY, MITCHELL & CO.

We are pleased to announce the formation of the firm of Parmly, Mitchell & Co. This concern has recently embarked in the electrical supply business, with offices in the Telephone Building, No. 18 Cortlandt street, New York City. The members of the firm are all favorably known to the electrical fraternity.

Mr. C. F. Parmly graduated from the Edison Machine Works in 1885 and joined the Marr Construction Company soon after it began to install Edison central stations. In the service of the Marr Co. and its successor, the North American Construction Co., Mr. Parmly, as superintendent, installed many important arc and incandescent plants all over the United States, and in Cuba. He is, by education and experience, a practical electrician and construction expert.

Mr. P. W. Mitchell is well known in the West, where he traveled several years, and also in the vicinity of New York City. He acquired a practical knowledge of construction with the North American Construction Co.; of general supplies he has a most extensive and valuable knowledge. He was until quite recently connected with the Electrical Supply and Construction Co., of Pittsburgh, the customers of which concern will congratulate him and his partners on the arrangement he has just consummated.

Mr. C. D. Doubleday joined the Marr Construction Co. during the period of its employment as Edison constructors and afterwards had with the Marr Co. and its successor a valuable Westinghouse training. He is better known in the East as the New York district manager in charge of the interests of the Marr Construction Co. and its successor, the North American Construction Co. This position he filled for about three years, and during this time under his management was installed, we are informed, upwards of $400,000 worth of electric light and railway work in the Eastern and Middle States, in the West Indies and in South America.

It will be admitted that with the knowledge these gentlemen collectively possess of electrical matters—the result of exceptional advantages—and with their large acquaintance with the trade, both consumers and dealers, they are well equipped to make a successful record in their chosen business.

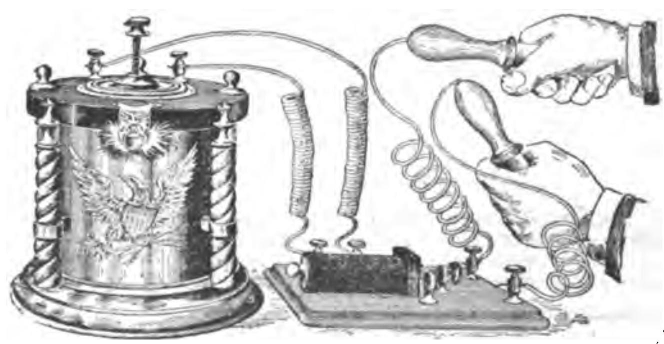
They have not as yet issued a catalogue, but when it appears it will advertise one particularly important feature. Parmly, Mitchell & Co. have secured the exclusive sales agency of the Columbia incandescent lamp, manufactured in St. Louis, Mo. The introduction of this electrical element in the East, where it has hitherto been but little known, could not have been put in better hands. They handle also a number of other specialties of value; sockets, cut-outs, switches, etc., the sale of which they control. It is a part of their plan to deal in all varieties of electrical supplies. We are well assured that, having had, as above stated, an exceptional education, they know where to go to get the best goods at the lowest figures, and it follows, therefore, that as general dealers they possess unusual advantages.

BELTS AND DRESSINGS.

Belts should be cleaned regularly, and, after cleaning, a good belt-dressing should be applied to keep the belt soft and elastic, and cause it to hug the pulley and transmit its greatest power. The use of a good belt-dressing is superior in economy to any other method for correcting a slipping or slightly loose belt. The custom of tightening a belt whenever it slips is not a good one. The belt is liable to be made too tight, which heats the bearings and strains the belt. Great care, however, should be taken in selecting a belt-dressing. A belt-dressing that is guaranteed to prevent slipping, and at the same time keep the leather soft and elastic, is certainly worthy of careful consideration. Such is Dixon's Belt-Dressing, made and sold by the Jos. Dixon Crucible Co., Jersey City, N. J. There is no trouble in applying it, and all who have used it commend it in the highest terms.

THE BARR ELECTRIC LIGHTER.

IN a recent number of THE ELECTRICAL ENGINEER appeared a description of the Barr cigar lighter, as it was then called, manufactured by the Barr Electric Manufacturing Co., of 17 and 19 Broadway, this city. Since the appearance of the article referred



THE BARR ELECTRIC LIGHTER.

to, however, the lighter has been applied to other uses, one of which is illustrated in the accompanying engraving. Instead of the medical coil attachment, a burglar alarm, call bell, or other device may be used, the lighter performing the office of an ordinary battery.

THE ELECTRIC CONSTRUCTION AND SUPPLY CO., of New York, has furnished installation for electric lights at the ferry house and docks of the Central Railroad of N. J., foot of Liberty street, New York. The specification called for, and there was used in the various buildings, upwards of 18 miles of Okonite wire and 2,000 feet No. 0000 Okonite cable underground. The installation consists of upwards of 300 incandescent, and 37 arc lights.

NEW YORK NOTES.

THE GOULDS MANUFACTURING Co., of Senaca Falls, N. Y., have been testing their large sizes of triplex pumps for electric motors, and the results thus far have been very satisfactory. This pump is especially designed for work in mines equipped with electricity.

THE ROCHESTER MACHINE TOOL WORKS, builders of the Acme Automatic Safety Engine, which burns kerosene oil or natural gas, report business as unusually brisk, and that a great many of their engines are being applied to electric light plants.

THE SYRACUSE TWIST DRILL Co., of Syracuse, who manufacture this well-known type of drill, which is extensively used in electric work, it being so designed that should the bit encounter a nail when boring through a partition, it will cause no damage to the drill, report business as very good, it being almost impossible to keep up with orders.

MR. W. VALKENBURGH, of Oneida, N. Y., sole manufacturer of the Crown Safety Water Column, recently received the following letter from the Smith Premier Typewriter Co., of Syracuse: "Some months ago we ordered of you one of your Crown Safety Water Columns, which you attached to our boilers at once. We wish to state that after using the same we have found that it meets every requirement imaginable, and all claims that you make for it are fully met with a practical test. It is an attachment that we would not want to do without in connection with our boiler."

MESSRS WALWORTH & GATLEY, two young men in the employ of the Rome Gas Light and Electric Co., have patented, and are placing on the market, a connection for arc lamps to eliminate the difficulties often encountered where the arc lamp is raised and lowered to be trimmed, as on mast-arms, etc. Their device consists of a hinge connection which relieves the wire of the pressure brought upon it when the lamp is lowered. This apparatus has been thoroughly tested and found to work entirely satisfactorily.

THE LITTLE HERCULES CHUCK.—The following letter has recently been received by the Oneida Mfg. Chuck Co., who make the Little Hercules Chuck:

"We have used several sizes of your Little Hercules Drill Chucks, and find them durable and efficient; in fact, they are all you claim them.

"Yours truly,
"THE GARVIN MACHINE CO.
"THOS. TOWNE."

THE PAGE BELTING Co. have assisted in the establishment of several mechanical and electric plants by means of furnishing their belting during the past month. The following are among the many parties whom they have supplied: Quincy Market Cold Storage Co., Boston; Mfg. Investment Co., of Madison, Me., including both link and flat belts, among the latter a three-ply large driving belt; Milton Electric Light Co., Milton, Mass.; Concord Street Railway Co., Concord, N. H.; E. W. Littlefield, East Boston, Mass.; Santley Lumber Co., Wilmington, Ohio, and a large establishment in Virginia. Among the various "Acme" link belts of their manufacture was a 12-inch belt for Carthage, N. Y., and one to Lynchburg, W. Va.

MR. J. D. WILKES, of Toledo, O., has become superintendent of the East Side Electric Railway Co., of Brockton, vice Reynolds, resigned.

PHILADELPHIA NOTES.

WRIGHT & STARR have transferred their car from the experiment station at Lehigh avenue to Chester, Pa., where they will introduce the Waddell-Entz system, making regular trips on the Potter street division of the Chester Street Railway Co.

MAJOR & MORRELL, 934 Ridge avenue, will act as Philadelphia agents for the Card Electric Motor & Dynamo Co., of Cincinnati, O., and have placed their first machine with a complete plant for Messrs. Bickle & Miller, 12 Vine street.

MR. WM. HAZELTON, 3D, of this city, has been appointed agent for Philadelphia and vicinity for The Short Electric Railway Co., of Cleveland, O. The wide experience which Mr. Hazelton has acquired will be no small means of bringing him the success which he doubtless will have with the Short gearless motor, of which he will make a specialty. Well-appointed offices will soon be fitted up in the new Penn Mutual Building, 925 Chestnut street. Room 601 is being used as temporary quarters.

WALKER & KEPLER have installed a plant for Messrs. N. W. Ayer & Son consisting of a 400-light Edison dynamo and a 7½ h. p. Edison motor. This plant will be so constructed that by turning a switch the plant can be run on either the 110 or the 220 volt circuit, from outside. This is the first plant of this kind ever installed in this vicinity. This firm have sold over $3,500 worth of ceiling fans and fan motors within the past ten days.

WESTERN TRADE NOTES.

THE HAY-HORN MANUFACTURING Co., of Chicago, have been appointed Western agents for the famous Mason primary batteries, which are manufactured by James H. Mason, of Brooklyn, New York.

MR. J. R. MARKLE, President of the Electrical Fibre Carbon Co., of Detroit, Mich., was in Chicago last week for a few days, and a caller at the Western office of THE ELECTRICAL ENGINEER.

MESSRS. SARGENT AND LUNDY, consulting mechanical and electrical engineers, report that business is good. They are now prepared to engaged in the construction work of electric street railway plants, and any work placed in their hands cannot fail to be carried out in the most thorough and perfect manner. Mr. Fred Sargent, who is well known in electrical circles, has had many years of experience in mechanical and electrical engineering with the E. P. Allis Co., of Milwaukee, Wis.; Robt. Wetherell & Co., of Chester, Pa., and later as assistant to the engineer-in-chief of the Edison General Electric Co. of New York. He is now the electrical engineer for the World's Fair. His assistant, Mr. Lundy, is one of the early workers in the street railway field and was the chief engineer of the Sprague Electric Equipment Co., and of the Southern district of the Edison General Electric Co. The firm are also the Western agents for the famous McIntosh & Seymour engines, of which they are installing large numbers in the West.

THE ELECTRIC MERCHANDISE Co., of Chicago, are furnishing a large number of street railways with the necessary line supplies, and business prospects are exceedingly bright. All the line equipment of the Sioux City electric street railway, Westinghouse system, which was recently started up, was supplied by this well-known company.

THE CHAS. MUNSON BELTING Co. are selling a large quantity of their Eagle and dynamo belting. They have recently been giving away a very handsome souvenir in the shape of a steel pocket rule, in a handsome leather case, which is exceedingly useful and handy.

THE ILLINOIS ELECTRIC MATERIAL Co. are meeting with quite a demand for the Russell arc lamps, which, it will be remembered, employ a circular carbon, thereby prolonging its life to almost any desired extent. Economic lamps, and Bishop and Canvas Jacket wires and cables are also selling well.

THE SPERRY ELECTRIC MINING MACHINERY Co. are very busy in their factory at 39th and Stewart avenue, building mining machinery, mining locomotives, street car motors, and other electrical apparatus, all of which show the very best workmanship and most excellent design.

THE GREAT WESTERN ELECTRIC SUPPLY Co., manufacturers, dealers, and importers, of electrical supplies of all kinds, are finding a ready sale for their goods, and their business is continually on the increase.

WILLIAM HOOD, the general agent for the Jewel incandescent lamps, is meeting with great success, and is receiving numerous orders for these lamps, which are giving first class results.

THE CLEVELAND WHEELBARROW AND MFG. Co.—The above-named company, manufacturers of the Cleveland wheelbarrows, trucks, pounders, mauls, hods, etc., have purchased the business of the Cleveland Wheelbarrow & Truck Co., and now have a largely increased capacity, which will insure the prompt execution of orders. Mr. J. W. Hornsey, who is known to many of our readers, becomes secretary and treasurer of the new concern.

THE EXCESSIVELY HOT WEATHER of the past week is what electrical people call "good fan weather," and the Central Electric Company report large sales of motor fans, and keep a variety of electric fans for customers to select from.

THE MORRIS TROLLEY-HANGERS are the only ones giving double insulation, and for this reason many railway plants insist on their use. George Cutter is making them in large lots, and hears only the most favorable comments on these hangers. They are all fitted with the strong and simple clamp ear, which experienced railway men favor so much.

J. E. HOCKETT was appointed general manager of the Card Electric Motor & Dynamo Co., of Cincinnati, O., June 15th, vice Mr. H. H. Walter, resigned. This company seems to be in a most flourishing condition on account of the largely increased demand for the Card motor. We understand the company contemplate increasing their facilities within the next sixty days.

☞ *Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.*

THE
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ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—VI.

BY

Chas. Steinmetz.

THESE circles, e_0, e, e_1, etc., Fig. 9, have still another interesting meaning, besides giving the instantaneous values of the electric quantities.

In alternate current engineering, the *effective* values of the electric quantities, that is, the *square-roots of the mean square*, are almost the only ones of any practical use; the "*mean*" or "*average*" values being almost useless.

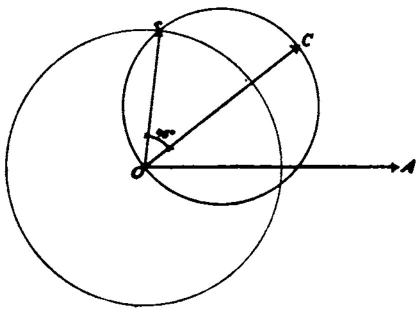


FIG. 10.

But in the usual representation by rectangular co-ordinates, this "effective" value nowhere appears, and the areas of the sine-waves give the "average," that is useless, values.

In the representation by polar co-ordinates, the area of those circles, which represent the sine-waves, are the *effective* values of the electric quantities, or rather, their *squares*.

This holds good not only for sine-waves, but for waves of any shape, which in the polar-diagram are represented by any curve whatever:

"*The radius of the concentric circle, the area of which equals the area of the wave of* E. M. F., *current, etc., in the polar diagram, is the effective value of the* E. M. F., *current etc.*"

This law holds for alternating, as well as pulsating, continuous, intermittent, or any kind of periodical currents, etc., of any desired shape.

The continuous current is represented in the polar diagram by a concentric circle, the alternating current of sine-shape, by the circle explained above, which is produced twice during each period, so that its area has to be counted twice.

"*All the electric currents, etc., which in the polar-diagram are represented by curves of equal area* (the area of those curves, which are produced twice during each period, counted twice), *have the same "effective" value, no matter whether they are alternating, continuous, pulsating, or any other kind of currents.*"

Hence, the effective value of an electric sine-wave is found in the polar-diagram in Fig. 10, by producing a line at an angle of 45° to the maximum value of the sine-wave, $\overline{o\,C}$. This line intersecting the circle, which represents the sine-wave, at c, $\overline{oc}$ represents the "effective" value of the sine-wave.

Proof:

If T is the period of a periodical current, which is given by the equation: $c = f(t)$; then its effective value is $\sqrt{\frac{1}{T}\int_0^T c^2\,d\,t}$; but the differential of the area of its polar-curve is $d\,A = \frac{c^2}{2}\,d\,\vartheta$, where $\vartheta = \frac{2\,\pi}{T}\,t$, and therefore, $d\,A = \frac{c^2\,\pi}{T}\,d\,t$.

The radius of the circle of the same area, A, being called R, gives, $R^2\,\pi = A = \frac{\pi}{T}\int_0^T c^2\,d\,t$; hence,

$$R = \sqrt{\frac{1}{T}\int_0^T c^2\,d\,t} = \text{effective value } c. \quad \text{Q. E. D.}$$

Therefore, for any shape of electric wave, the effective value can be derived graphically by producing the wave in polar co-ordinates and measuring its area.

V. *Magnetic Leakage in the Transformer.*

In the former construction, it was supposed that every line of magnetic force produced by, and surrounding, the primary coil, surrounds the secondary coil also, and inversely, so that no lines of magnetic force are "short-circuited," by surrounding only one of the coils.

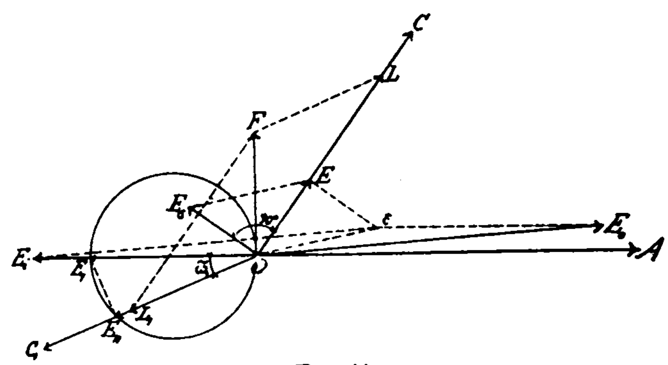


FIG. 11.

Very approximately this will be the case in all the better types of transformers, except where, for constant-current regulation, magnetic leakage is intentionally produced.

If, as in the instance of constant-current transformers, magnetic leakage has to be taken into consideration, this may be done in the following manner; Let σ_1 = the *magnetic resistance of the secondary magnetic leakage current*, that is, of those lines of magnetic force, which, produced by the secondary coil, do not intersect the primary coil, but only surround the secondary proper. Then the number of these lines of magnetic force will be, $M_1^\sigma = \frac{n_1 C_1}{\sigma_1} = \frac{n_1 E_1}{\sigma_1 R_1}$, hence the E. M. F. induced by them is,

$$E_1^\sigma = 2\pi n_1 N M_1^\sigma 10^{-8} = \frac{2\pi n_1^2 N E_1}{\sigma_1 R_1}$$

and the shifting of phase of the secondary current against the secondary E. M. F., caused thereby is,

$$\sin \omega_1 = \frac{E_1^\sigma}{E_1} = \frac{2\pi n_1^2 N}{\sigma_1 R_1}.$$

Hence the magnetic leakage acts upon the secondary like ordinary self-induction (as it really is), which shall be considered more particulary later, producing a shifting of phase by an angle ω_1.

Let, for instance, this angle $\omega_1 = 22.5$ degrees. Now, after producing in the diagram in Fig. 11 in the usual way, $\overline{OF} = 2400$ ampere turns $= .72$ inch, $\overline{OE_1} = 100$ volts $= 1.00$ inch, we now draw a half circle with diameter $\overline{OE_1}$ and make angle $E_1 O E_{11} = \omega_1 = 22.5°$, then $\overline{OE_{11}} = .923$ inch $= 92.3$ volts is the *resulting* E. M. F. *of the secondary circuit*, and produces the *current* $\overline{OC_1} = 46.15$ amperes $= 1.385$ inch.

The secondary M. M. F., $\overline{OL_1} = 2770$ ampere turns $= .83$ inch, which combines with the primary M. M. F., $\overline{OL}$ to the resulting M. M. F., $\overline{OF} = .72$ inch[1] by the parallelogram of sine-waves O L, F L, and thus gives the *primary* M. M. F., $\overline{OL} = 1.29$ inch $= 4300$ ampere turns.

The *primary current* $\overline{OC} = 53.8$ amperes $= 1.61$ inch and the *primary resulting or heating* E. M. F., $\overline{OE} = 53.8$ volts $= .538$ inch.

Now this primary current $\overline{OC}$ produces by its leakage magnetism a counter E. M. F., E^σ, which is found in the same way as E_1^σ, and lags behind C by one-quarter of a period, or 90°.

Let this *counter* E. M. F. *of primary self-induction* $E^\sigma = 50$ volts; then it is represented in the diagram Fig. 11, by the ray, $\overline{OE^\sigma} = .50$ inch.

The *induced primary* E. M. F., $\overline{OE_1} = 133$ volts $= 1.33$ inch combines with the impressed primary E. M. F., $\overline{OE_0}$, and the self-induction E. M. F., $\overline{OE^\sigma} = 50$ volts by the polygon of sine-waves V, or successively by parallelograms of sine-waves W, to the resulting primary E. M. F., $\overline{OE} = 53.8$ volts.

From this we get the *impressed primary* E. M. F., $\overline{OE_0} = 2.06$ inch $= 206$ volts.

Hence magnetic leakage in the transformer produces a shifting of phase in the secondary, as well as in the primary circuit, and thereby a decrease of the resulting secondary E. M. F., which decrease will increase with increasing secondary current, and thus show the tendency to keep the current more constant.

For the same reason, for constant-potential transformers, leakage should be carefully avoided, because it decreases the compounding of the converter.

1. We neglect again hysteresis and eddies, not to complicate the diagram unnecessarily.

TERRESTRIAL MAGNETISM.

One result of the magnetic researches of M. Moureaux and others is to render practically obsolete the old-fashioned magnetic charts with their mathematically regular curves. M. Moureaux is engaged in drawing up charts showing the "isanomal" lines, or curves, passing through the points of maximum abnormality.

M. Moreau, we learn, will shortly show at Brussels an electric voting machine. It has a series of electric buttons, above which are ranged the names of the various candidates. Pressing a button registers one vote on a numbered dial. This can be locked up until the voting is complete, rendering the tedious counting unnecessary.

THE EFFICIENCY OF QUARTZ FIBRES AS A MEANS OF SUSPENDING GALVANOMETER NEEDLES.

BY

Henry M. Fisher.

Anyone who has used short silk fibres for suspending galvanometer needles, knows how unreliable large deflections of the galvanometer needle may be, on account of the needle failing to return to its zero or starting point. Hence, several months ago, it was with a great deal of pleasure that the writer heard of the excellent qualities claimed for quartz fibres as a means of suspending galvanometer needles. Upon inquiry it was found that these fibres, in 15-inch lengths, could be imported for the sum of $8 apiece, but no definite information as to their strength or sensitiveness could be obtained. Hence the writer determined to make some, and give them a test with a view to using them in place of silk.

An ordinary arc lamp was placed on a convenient table, and in front of the lamp a large pane of smoked glass was arranged so that the arc could be clearly observed without injury to the eye.

Off to the right of the arc a long, light wooden arm was mounted on a pivot. At the extreme end of this a small spring clasp, such as could be used to grip firmly a piece of quartz, was fastened rigidly. A strong spring was arranged so that it would cause the arm to revolve instantly through half a revolution, and thus the piece of quartz could be made to go through a distance of seven or eight feet very rapidly. The quartz used was the kind that is so prevalent in the form of white pebbles. These were broken up into pieces of a convenient size.

In making these fibres the plan of procedure was as follows: A piece of quartz was held in the edge of the arc by means of a tongs, and then the piece attached to the movable arm was made to touch this until both pieces of quartz were fused at the point of contact. Then they were removed instantly out of the arc where the heat was not sufficient to fuse the fibre, the arm being liberated at the same time. A fibre was thus made whose size depended upon the amount of quartz that was fused, upon the distance traversed by the moving quartz, and upon the rate of its motion. The state of fluidity also was found to materially affect the size of the fibre. Many attempts were made before the very fine fibres, such as will be described later, were produced. Practice showed that better results could be obtained by regulating the rate and distance of the movement of the arm by means of the hand, as both of these depend upon the size of the globule of fused quartz, and upon its fluidity. Good results were obtained by melting a very small globule of quartz and then drawing it quickly through a distance of five or six feet. One of the most difficult parts of the operation was the securing of the fibres after they were made. This was especially true of the very delicate ones which were scarcely visible to the naked eye. These were preserved for future use by placing them on strips of hard rubber and fastening the ends with mucilage or liquid shellac. As soon as a portion of one of these was needed the desired length was measured and before cutting the fibre a little mucilage was placed on the rubber so that the remaining portion of fibre would not blow away, after the desired part was removed. Some of the fibres were so small that they were with difficulty discernible, even on the hard rubber. Hence it will be understood how much care is required to fasten one of these in place between the galvanometer needle and the rod from which the needle is suspended.

This operation can be accomplished with dispatch and certainty by the following method: Place the rod and galvanometer needle at the right distance apart in a suitable wooden frame. Then dip the point of a needle into a paste made of shellac dissolved in alcohol. By means of the shellac adhering to the needle, secure temporarily one end of the quartz fibre to the galvanometer needle; in a similar manner fasten the other end to the snspension rod. Then evaporate the alcohol by applying a hot iron to the pasty shellac, after which the rod and galvanometer needle are ready to be placed in their relative positions in the galvanometer.

Having thus briefly dwelt upon the method used in making quartz fibres, the writer will now speak of the tests to which they were subjected. Before entering upon this, however, it might be well to state that the data relative to silk fibres applies to the silk of the South American silk spider, several cocoons of which the writer gathered in the Argentine Republic. This silk was found to be very tough, and to answer admirably for experiments where very great accuracy is not desired. The measurements and tests of quartz fibres apply neither to the largest nor to the smallest that were made, but to a size that was found to be suitable for the purposes under consideration.

The dimensions of the fibres are as follows:

Diameter of quartz fibre = .0068 millimeter = .00027 inch,
" " silk " = .015 " = .0006 "
Length of suspension of quartz fibre = ¾ inch,
" " " " silk " = ¾ "
The quartz fibre stood a maximum tensile strain of 70 grains,
" silk " " " " " " " 63 grains.

Reducing to equivalent dimensions it appears that the quartz fibre is 5.4 times stronger than the silk fibre.

From the above measurements it follows that one square inch area of quartz fibre would stand a tensile strain of 172,000 lbs., and a square inch area of silk fibre would stand a tensile strain of 31,800 lbs. From this we see that quartz is over 1½ times stronger than ordinary steel.

In making tests to illustrate the sensitiveness of the quartz fibre, a Thomson reflecting galvanometer of the square pattern was used. It had an astatic needle, two coils actuating one set of magnets, and two lower coils actuating the other set. The resistance of the galvanometer was 10,000 B. A. ohms. The distance between the scale and the mirror was 39½ inches and 40 scale divisions = 1 inch.

By means of the controlling magnet the galvanometer needle was made very sensitive, and then 1 Leclanché cell, having an electromotive force of 1.49 volts, gave a deflection of 320 scale divisions through 100,000 ohms, the $\frac{1}{999}$ shunt plug being inserted.

This, of course, would mean a deflection of 320,000 scale divisions were all the current allowed to pass through the galvanometer, or a deflection of 32,000 scale divisions through one megohm.

From this it is apparent that with one cell an insulation resistance of 32,000 megohms could be detected, and when 100 cells are used, which is the custom in making insulation resistance tests, enormously high resistances can be measured. Surface leakage across such a good insulator as hard rubber can be detected. Under such sensitive conditions the galvanometer and battery should, of course, be very highly insulated, otherwise the measurements made cannot be relied upon. Any movement of iron in the neighborhood will also very materially affect the galvanometer needle.

The most remarkable part of this test was the fact that the needle invariably returned to its zero or starting point. This would not be strange were the experiment performed with a long suspension fibre, but when we consider that the fibre used was only ¾ inch long and that the needle was deflected in some of the tests through five or six hundred scale divisions, this return to zero must be considered quite remarkable.

A single silk fibre was next tested; the galvanometer needle being placed as nearly as possible under the same conditions of sensitiveness. A Leclanché cell having an electromotive force equal to 1.49 volts gave a deflection of 70 scale divisions through 100,000 ohms, the $\frac{1}{999}$ shunt plug being inserted. Under similar conditions the deflection with the quartz fibre in use was 320 scale divisions, therefore, in this particular case, the quartz fibre was about 4½ times more sensitive than the silk fibre. The needle, however, failed to return to its starting point when the silk fibre was used, and this feature became very marked under conditions of extreme sensitiveness. When seven cells were used a deflection of about 600 scale divisions was obtained, but upon breaking the battery circuit the needle failed immediately to return to its starting point to the amount of about 100 divisions. Hence it is evident how unreliable silk is for delicate work.

Remembering that it is possible to make very much smaller quartz fibres than those described in this article, the manifold uses to which these attenuated threads can be applied become at once apparent. For electrometer purposes they are unexcelled, and they will be received with enthusiasm by the ambitious physicist who would go over the experiments of Cavendish to demonstrate once more the laws of universal attraction by means of lead balls.

LIGHTNING PROTECTION.

BY

A. A. Knudson.

The recent paper by Mr. Hodges read before the Institute in April last, and also the article by Mr. C. J. Hubbell in The Electrical Engineer of 17th inst., have interested me away here in Canada, and induced me to say a few words on this interesting subject.

In regard to Mr. Hodges' theory, that of "*dissipating conductors*" being a protection to buildings, even should it be correct, there are, I think, obstacles in the way of its application which would render it impractical and interfere with its general use. For instance, the small copper ribbon which is to be placed on buildings is put there with a view to being "dissipated" or destroyed at the first discharge of lightning which strikes the building. After being destroyed (if the building is still there) the strips must be replaced again, and this might occur several times in one summer. In fact, cases have been known where buildings have been struck more than once during the same shower. After the first discharge, when the conductors had been destroyed, the building would then be left to the mercy of the second. Again, take the case of protecting tall chimneys and church steeples with "dissipating strips." After once being destroyed, how could they be replaced? In some cases this would be impossible, in others very difficult and expensive.

Again, in the light of experience, I think there are good reasons for believing that a building equipped with these strips would be in more danger of being damaged or destroyed by the effects of lightning than without them. Take, for instance, one that has gas and water pipes in its interior, also wires, iron posts, and other metals which form part of its construction. All these offer a more or less good outlet to ground. Should the copper strips be placed in proxmity to these interior metals, lightning in its descent would be likely to jump through the building to some of these metals in its efforts to find a more perfected ground conductor, thereby damaging, and possibly setting it on fire. A case in point occurred in Brooklyn a few years ago when the tall steeple of the Classon Avenue Presbyterian Church was struck by lightning. As this was a case near at home, I took occasion to investigate and see if there were any reason why the Franklin rod which ran from the top of the steeple to the ground was not able to carry off the discharge without damage to the building. I found what might be expected where rods in similar cases have failed to protect. *About ten feet of it was missing at the ground end.* The lightning followed the rod down the steeple until it came opposite some iron work inside, when it tore a hole through the steeple, scattering the slate, shingles, and woodwork in every direction, and finally passed off to the ground without further damage.

A similar condition of things would prevail, I think, with any strips of metal on a building that were not well grounded, as in the case of "dissipating" strips. Mr. Hodges states in one part of his paper that "there is no need of providing a good earth connection," and that "there is no need of the conductor following the shortest course to the ground."

Thus, with one sweep of the pen as it were, he attempts to upset the well-established laws of electrical action that have been accepted for the past one hundred years. But Mr. Hubbell ably defends the Franklin principle of lightning rods from his practical business standpoint, and his reference to experiments with models of oil tanks five years ago calls to mind my own experiments of nine years ago, when I conducted a series of very similar tests while illustrating a paper which was read before the New York Electrical Society. At that time I used one of the largest electrical machines to be had in New York to produce the lightning, and a copper cylinder suspended from the ceiling represented the charged thunder cloud. Under this were placed models of oil tanks equipped with various forms of lightning conductors, among them one that was freely advocated at that time and was similar in principle to the "dissipating" system. It, however, was made of larger metal than strips, and was placed upon insulators, but had no ground connection; the result of the test I well remember, and I pointed out at the time that, with each discharge to the tips of the conductors, sparks appeared at various places between the conductor and iron roof of the tank. These sparks were the very thing to be avoided in such a place, as the ignitable gas in and about an oil tank was the cause of many explosions and the destruction of much property every summer.

The system of protecting oil tanks from lightning, which I recommended and showed at that time, could not be made to produce a spark, although subjected to the most powerful discharges of which the machine was capable. This plan of protection was based on the Franklin principle with special means for making permanent well-grounded conductors, and was endorsed by letters from such men as Prof. Morton, Mr. Edison, Mr. Frank Pope, Prof. Elisha Gray, and others. I also had the same experience in my negotiations with the Standard Oil Co., as Mr. Hubbell, so far as their adopting the device is concerned, with the possible difference of mine being adopted in a modified form so as to evade the patent.

So far as the protection of buildings from lightning is concerned, I believe the old Franklin principle is the only true one, and very few doubters, I think, can be found among electrical men at the present day on this point. Where there have been failures, it is certainly due to improper construction, or a rod has been allowed to become inoperative on account of being damaged, such as the one on the church above referred to.

During the construction of the electric power station with which I am connected here in St. John, N. B., I had placed upon the chimney, which is of brick, and one hundred feet high, a good-sized copper wire stapled direct to the brickwork, the top terminating in the iron cap; a six-foot rod held by a tripod with points at the top completed the terminal. The lower end is firmly secured to the city water mains. I should consider it a piece of neglect if the designer of an electric light station omitted this point of lightning protection, for many a station manager knows to his cost what it is to have lightning jumping through dynamos.

Lightning arresters of special manufacture are now made for the purpose of being placed on wires where they pass out of a station, all based on the old and accepted Franklin principle. If lightning comes in over the wires or down the chimney a convenient and easy path to earth is offered, so that it will not injure or destroy instruments or dynamos.

Lightning conductors, however, should be made of sufficient size so that they will carry the heaviest discharge of lightning without becoming "dissipated." It would, indeed, be a sad state of affairs should one come to his station some morning and find that the lightning in the night had *chewed up*, as it were, his chimney conductor, and be confronted with the problem of how to replace it. In conclusion, I may say the only appropriate places for "dissipated' conductors I can think of are inebriate asylums and penitentiaries.

CENTRAL STATION MANAGEMENT AND FINANCE.—X

BY

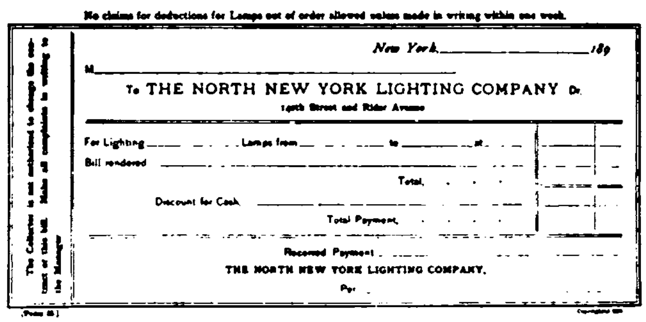
Horatio A. Foster

Department of Accounts.

Form No. 24 is recommended for recording the reading of meters as taken at stated periods. This also is in loose

BLANK NO. 24.—METER RECORD.

sheets to be kept in a holder. All calculations can be made on the forms Nos. 5 and 24, and the results only entered in a common ledger, if thought best; in which case it is


No claims for deductions for Lamps out of order allowed unless made in writing within one week.

New York, 189

M

To THE NORTH NEW YORK LIGHTING COMPANY Dr.

For Lighting Lamps from to at

Bill rendered

Total,

Discount for Cash,

Total Payment,

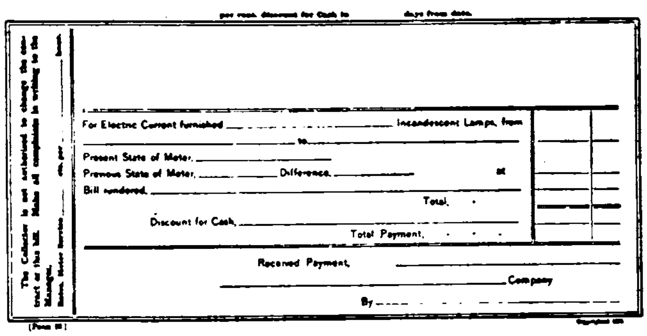
Received Payment

THE NORTH NEW YORK LIGHTING COMPANY.

Per

BLANK NO. 25.—LIGHT AND MOTOR BILL.

unnecessary to provide any special form of that book. Many stations have customers so prompt that the above forms are all the accounts necessary to keep, as when all accounts are settled during the month the lump sum can


per cent. discount for Cash in days from date.

For Electric Current furnished Incandescent Lamps, from to

Present State of Meter,

Previous State of Meter, Difference, at

Bill rendered,

Total,

Discount for Cash,

Total Payment,

Received Payment,

Company

By

BLANK NO. 26.—METER BILL.

be credited to lighting account without carrying any customers' accounts at all.

For bills to send to customers for service of light or power, Blank No. 25 is a convenient form for arc lights or motors, and monthly or contract incandescent lamps. Blank No. 26 is a bill designed for meter service and can be printed to accommodate stations running on watt-hours, or lamp-hours, or ampere-hours, as desired.

THE ELECTRIC RAILWAY AT SIOUX CITY, IOWA.

BY

THE formal opening of the Riverside Park Railway, at Sioux City, Iowa, occurred on the 19th of June, and the first cars passed over the line carrying a party of gentlemen, among them the owners of the road, and the representatives of the companies who furnished the equipment and of the daily and technical press.

In this particular case, the ideal of the electric railway has been realized, steam giving way to electricity. The results accomplished are very much in favor of the new method of propulsion, smoke, dust, dirt and noise being done away with, rendering a trip on the cars one of comfort and pleasure. It is also noteworthy that the operation is far less costly, easier and more reliable, and the electric car shows itself fully equal, and in many respects, superior, to the steam locomotive.

The line comprises some nine miles of road, commencing at the centre of Sioux City and running out as far as North Riverside, a new addition to Sioux City, where a large number of factories, employing many workmen, are situated. Besides taking care of the travel at North Riverside, the Suburban Electric Railway carries a very large number of people from Sioux City to Riverside Park, which is a noted pleasure resort in this part of the country, from its great natural beauty. It contains about 400 acres of land, situated on the bank of the Sioux river.

From the centre of the city the road starts out with double track as far as the bridge across Floyd Creek, where it becomes single track, equipped with single-pole bracket construction, on one side of the track; and notwithstanding that the line in all has about thirty-eight curves varying from four to twenty degrees, it was found unnecessary to employ curve brackets or appliances,

FIG. 1.—ELECTRIC RAILWAY, SIOUX CITY, IOWA.

the specially designed trolley hangers being capable of permitting the trolley wire to conform to the curves of the road.

Cuttings and fills form one of the features of the road, the former having from fifty thousand to one hundred yards of earth excavated in building the road, the earth being used for crossing the numerous valleys. Fig. 1 shows the old line descending to Riverside and also one of the depots; Fig. 2 is a very picturesque view of the car ascending from the valley. The trestle work, which forms quite a feature of the road is 634 feet long and having a 19 degree curve of 300 feet, with a rise of 4 per cent. The trestle crosses the Chicago, Milwaukee and St. Paul tracks at an elevation of 34 feet, and a most magnificent view is obtained while running over it, of the surrounding country.

The power plant is installed in a handsome brick building 62 x 95 feet, at Riverside. The steam plant comprises two 60 inch x 16 feet Worthington pumps, Krochell heater, Hancock inspirators and four sets of steam loops which are installed to insure the successful and economical operation of the engines. Westinghouse, Church, Kerr & Co. were the contractors for the complete steam plant. Two Westinghouse compound engines, each of 125 h. p., are employed, driving by direct belting two 100 h. p. generators, each run at 350 R. P. M. The current is conveyed to a very handsome switchboard, made of polished sycamore with marble face, on which all the switches and instruments are placed.

There are three circuits, the new Westinghouse circuit-breakers being used, and the engineers in charge of the plant express their approbation of the efficacy of this ingenious apparatus.

The car house, which is in close proximity to the power house, is 50 x 150 feet, and has four tracks the entire length of the building, with ample pit room. A complete outfit of track switches is

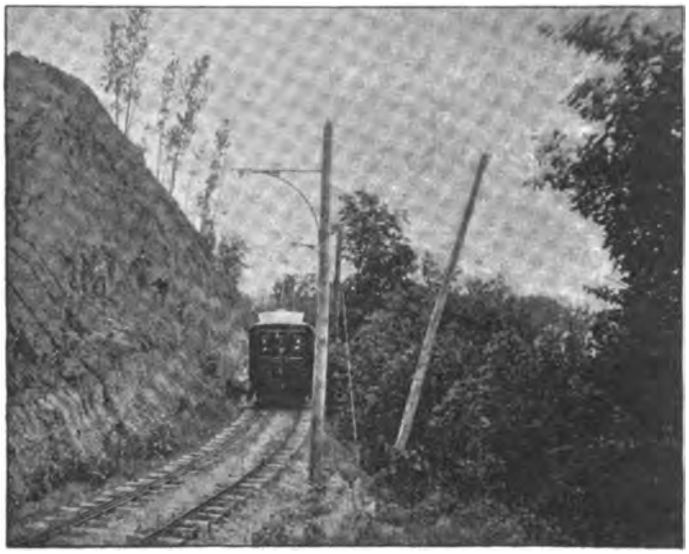


FIG. 2.—ELECTRIC RAILWAY, SIOUX CITY, IOWA.

laid in front of the car house, and switch signal lights are employed on the road, which is run in a manner exactly similar to a steam road.

Each motor car is equipped with two 30 h. p. motors, built by the Westinghouse Electric and Mfg. Co., and runs at a speed of 25 miles an hour easily, and as soon as certain improvements which are going on are made in the track even higher speeds than this will be reached. The six motor cars and six trailers now in use, were built by the Northern Car Co., of Minneapolis. The former are vestibuled, very beautifully finished and upholstered, their entire length being 36 feet. The trail cars are open, 36 feet long, and have seating capacity for 78. The trucks for all these cars were furnished by the McGuire Mfg. Co., of Chicago, and are of latest pattern Hubbard truck, and built specially for the high speed used on this road.

The electrical installation of the plant was in charge of Mr. B. F. Jones, the electrical engineer for the Westinghouse Electric and Mfg. Co., and great credit is due him for the very careful way the work has been carried out and especially the pole-and-bracket construction, which is one of the neatest and most symmetrical pieces of work ever done. The feed wires are No. 000 Roebling wires. All the overhead material, insulators, brackets, etc., was furnished by the Electric Mdse. Co., of Chicago, and much of the success of the road is due to the material furnished, the result of their long and practicable experience in building roads and manufacturing line material.

The necessities of the road, owing to the sharp and continual curves, grades, etc., were such that special devices were needed, and these were promptly designed by the Electric Mdse. Co., who have been complimented very highly for the successful manner in which they met and overcame the difficulties incident to the construction.

The equipment of the line compares favorably with anything built up to date and in many particulars surpasses anything yet attempted.

No expenses were spared to make the system perfect, and Mr. C. W. Hornick, president of the road, is justly gratified with his plant.

Mr. J. M. Atkinson, of the Westinghouse Co., was present and took charge of the lever to start the car, evincing as he did so, most complete satisfaction.

After the formal opening of the road Mr. J. Livingston Barclay and Mr. Atkinson, representing the Westinghouse Co., entertained the gentlemen interested in the road, the local press, and visitors, at the Hotel Garretson, and remarks of approbation at the splendid success achieved were heard on all sides.

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VOL. XII. NEW YORK, JULY 8, 1891. No. 166.

It is not enough for a physical investigation that we have the simple idea, which may be embodied in a mathematical equation; we must see clearly in the mind's eye the operations in nature, and how the phenomena are produced in accordance with the well-known laws of force and motion.—Joseph Henry.

MR. TESLA'S LECTURE.

NOW that we have the full text of Mr. Tesla's paper before us, we are better able to judge of the character and scope of his work. The ground covered by Mr. Tesla is so vast that even in his somewhat extended paper he has, as he states, only been able to pay passing notice to many facts, each one of which might have been made the subject of a separate paper; and it is to be hoped that he may shortly find time to enter more into the detail of the various points brought out.

Although Mr. Tesla's work has relation to many matters of the highest importance and discloses some startling possibilities, yet its immediate bearing on the question of producing light economically is perhaps that which will appeal most strongly to the electrical engineer.

Taking up the course of reasoning followed by Mr. Tesla, it will be noted that he started out with the recognition of the fact, which he has now experimentally demonstrated, that for the production of light waves, primarily, electrostatic effects must be brought into play, and continued study has led him to the opinion that all electrical and magnetic effects may be referred to electrostatic molecular forces. This opinion finds a singular confirmation in one of the most striking experiments which he describes, namely, the production of a veritable flame by the agitation of electrostatically charged molecules. It is of the highest interest to observe that this result points out a way of obtaining a flame which consumes no material and in which no chemical action whatever takes place. It also throws a light on the nature of the ordinary flame, which Mr. Tesla believes to be due to electrostatic molecular actions, which, if true, would lead us directly to the idea that even chemical affinities might be electrostatic in their nature and that, as has already been suggested, molecular forces in general may be referable to one and the same cause. This singular phenomenon accounts in a plausible manner for the unexplained fact that buildings are frequently set on fire during thunder-storms without having been at all struck by lightning. It may also explain the total disappearance of ships at sea.

One of the striking proofs of the correctness of the ideas advanced by Mr. Tesla is the fact that, notwithstanding the employment of the most powerful electromagnetic inductive effects, but feeble luminosity is obtainable, and this only in close proximity to the source of disturbance; whereas, when the electrostatic effects are intensified, the same initial energy suffices to excite luminosity at considerable distances from the source. That there are only electrostatic effects active seems to be clearly proved by Mr. Tesla's experiments with an induction coil operated with alternating currents of very high frequency. He shows how tubes may be made to glow brilliantly at considerable distances from any object when placed in a powerful, rapidly alternating, electrostatic field, and he describes many interesting phenomena observed in such a field. His experiments open up the possibility of lighting an apartment by simply creating in it such an electrostatic field, and this, in a certain way, would appear to be the ideal method of lighting a room, as it would allow the illuminating device to be freely moved about. The power with which these exhausted tubes, devoid of any electrodes, light up is certainly remarkable.

That the principle propounded by Mr. Tesla is a broad one is evident from the many ways in which it may be practically applied. We need only refer to the variety of the devices shown or described, all of which are novel in character and will, without doubt, lead to further important results at the hands of Mr. Tesla and other investigators. The experiment, for instance, of lighting up a single filament or block of refractory material with a single wire, is in itself sufficient to give Mr. Tesla's work the stamp of originality, and the numerous other experiments and effects which may be varied at will are equally new and interesting. Thus, the incandescent filament spinning in an unexhausted globe, the well-known Crookes experiment on open circuit, and the many others suggested will not fail to interest the reader. Mr. Tesla has made an exhaustive study of the various forms of the discharge presented by an induction coil when operated with these rapidly alternating currents, starting from the thread-like discharge and passing through various stages to the true electric flame.

A point of great importance in the introduction of high tension alternating current which M. Tesla brings out is the necessity of carefully avoiding all gaseous matter in the high tension apparatus. He shows that, at least with very rapidly alternating currents of high potential, the discharge may work through almost any practicable thickness of the best insulators, if air is present. In such cases the air included within the apparatus is violently agitated and by molecular bombardment the parts may be so greatly heated as to cause a rupture of the insulation. The practical outcome of this is, that, whereas with steady currents, any kind of insulation may be used, with rapidly alternating currents oils will probably be the best to employ, a fact which has been observed, but not until now satisfactorily explained. The recognition of the above fact is of special importance in the construction of the costly commercial induction coils which are often rendered useless in an unaccountable manner. The truth of these views of Mr. Tesla is made evident by the interesting experiments illustrative of the behavior of the air between charged surfaces, the luminous streams formed by the charged molecules appearing even when great thicknesses of the best insulators are interposed between the charged surfaces. These luminous streams afford in themselves a very interesting study for the experimenter. With these rapidly alternating currents they become far more powerful and produce beautiful light effects when they issue from a wire, pinwheel or other object attached to a terminal of the coil; and it is interesting to note that they issue from a ball almost as freely as from a point, when the frequency is very high.

From these experiments we also obtain a better idea of the importance of taking into account the capacity and self-induction in the apparatus employed and the possibilities offered by the use of condensers in conjunction with alternate currents, the employment of currents of high frequency, among other things, making it possible to reduce the condenser to practicable dimensions. Another point of interest and practical bearing is the fact, proved by Mr. Tesla, that for alternate currents, especially those of high frequency, insulators are required possessing a small specific inductive capacity, which at the same time have a high insulating power.

Mr. Tesla also makes interesting and valuable suggestion in regard to the economical utilization of iron in machines and transformers. He shows how, by maintaining by continous magnetization a flow of lines through the iron, the latter may be kept near its maximum permeability and a higher output and economy may be secured in such apparatus. This principle may prove of considerable commercial importance in the development of alternating systems. Mr. Tesla's suggestion that the same result can be secured by heating the iron by the hysteresis and eddy currents, and increasing the permeability in this manner, while it may appear less practical, nevertheless opens another direction for investigation and improvement.

The demonstration of the fact that with alternating currents of high frequency sufficient energy may be transmitted under practicable conditions through the glass of an incandescent lamp by electrostatic or electromagnetic induction may lead to a departure in the construction of such devicces. Another important experimental result achieved is the operation of lamps, and even motors, with the discharges of condensers, this method affording a means of converting direct or alternating currents. In this connection Mr. Tesla advocates the perfecting of apparatus capable of generating electricity of high tension from heat energy, believing this to be a better way of obtaining electrical energy for practical purposes, particularly for the production of light.

While we were prepared to encounter curious phenomena of impedance in the use of a condenser discharged disruptively, the experiments shown were extremely interesting on account of their paradoxical character.

The burning of an incandescent lamp at any candle power when connected across a heavy metal bar, the existence of nodes on the bar and the possibility of exploring the bar by means of an ordinary Cardew voltmeter, are all curious developments, but perhaps the most interesting observation is the phenomenon of impedance observed in the lamp with a straight filament, which remains dark while the bulb glows.

Mr. Tesla's manner of operating an induction coil by means of the disruptive discharge, and thus obtaining enormous differences of potential from comparatively small and inexpensive coils, will be appreciated by experimenters and will find valuable application in laboratories. Indeed, his many suggestions and hints in regard to the construction and use of apparatus in these investigations will be highly valued and will aid materially in future research.

Looked at from the standpoint of scientific research we believe that Mr. Tesla's paper will be conceded to be one of the most remarkable productions of recent years, and worthy of a very high rank among the classical publications on electricity. In addition to its great scientific value, however, it opens up possibilities not only in the production of light, but of power, the contemplation of which, as Mr. Tesla eloquently puts it, "expands our minds, strengthens our hopes and fills our hearts with supreme delight."

THE SUPPLANTING OF STEAM AT SIOUX CITY.

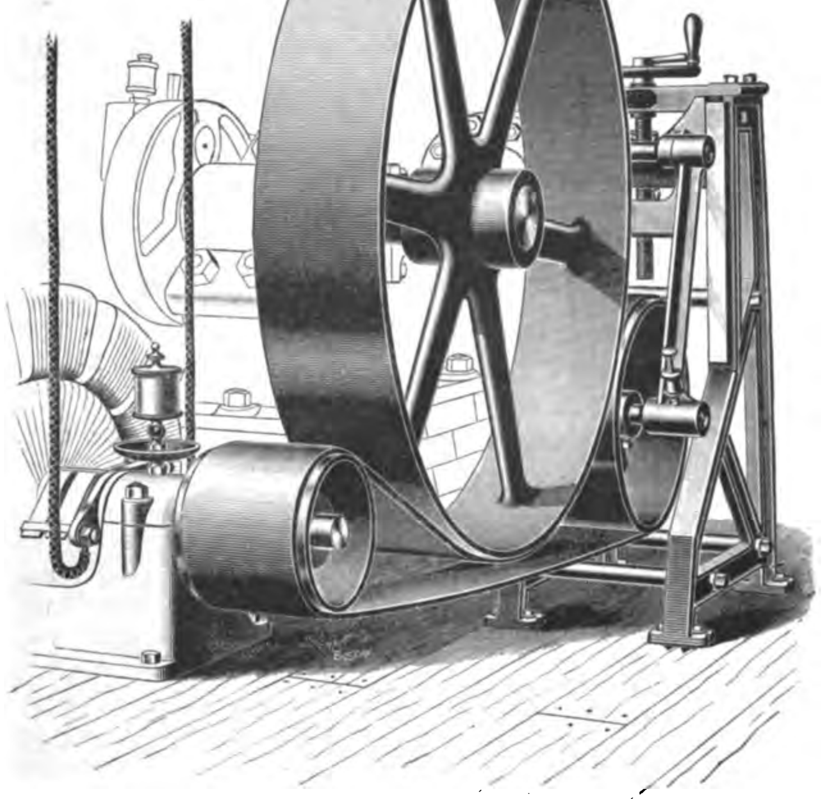
It is interesting to note that on another steam road out West the change to electricity has been made that has already been so significant and so successful in the service between St. Paul and Minneapolis. In the present case, the Riverside Road, running out of Sioux City for nine miles, the advantages of electricity have again demonstrated themselves so clearly, that we believe it is only a matter of a few months when a great many other short and "commuter" roads around the larger cities will adopt electricity as their motive power. This new Westinghouse road, about which Iowa is very enthusiastic, compares in every way with regular steam railways, for it was one. There is a standard railway track with deep cuts and fills, trestle-work 600 feet long, depots, and a speed of 25 miles an hour, which is to be soon improved upon. The people of the city and all that wide suburban region have every benefit that rapid transit can bestow, but they travel now without the accompaniments of smoke, soot and flying cinders, and without the possibility of setting fire to grass or trees. Steam locomotion has been an enormous boon to suburban residents, but electricity, as something far better, now claims the field. The fact that this extension of electric railway work has already begun, while yet the street railway work that it was to follow is in the early stages, must be most gratifying to all who take part in it, and shows once again how rapid electric development in this country is, when the apparatus has been proven equal to its work.

THE "L. P. & D." METHOD OF DRIVING DYNAMOS.

In an electric plant, for the production of either light or power, much space is necessarily taken up with the belting and countershafts, and engineers have for years been trying to find some method of applying the power from the engines more directly to the pulley of the dynamos. There are many so-called friction drives in use to-day, some of which have proved very successful, while some have had to be abandoned, owing either to their unreliability or to the cost of necessary repairs. We illustrate in the accompanying engraving the L. P. and D. system, which is entirely new, though it has been successfully tried in two or three electric light stations for the past year. The figure shows the general principle of the machine, in which a dynamo is being driven direct from a high-speed engine, though the system can be equally well applied to a pulley on a line of shafting. The dynamo is bolted firmly to the floor, and does not require any sliding base, and it will be at once seen that the belt has a contact on two-thirds of the dynamo pulley, thereby preventing liability to hot bearings, there being much less strain. A strong cast-iron frame is set up behind the driving pulley, with a swinging frame attached to it carrying an idler pulley, called the transmitter pulley, round which the driving belt has to pass. The engine pulley is revolving, as represented in the cut, so that the top of the pulley is approaching the observer. When not in use the belt hangs loose, and in starting all that is necessary to do is to screw up the hand wheel on top of the frame, which draws up the transmitter and tightens the belt against the engine pulley, and the dynamo is gently and evenly set in motion. There is not belt wrap enough on the driving pulley to carry a large load, but the belt is supported in such a manner by the transmitter pulley that it is gripped firmly between it and the driving pulley, and as the arrangment is such that the grip increases with the pull of the belt, it follows that the machine is automatic.

Belts that have been running one year on this system show no more wear than those used in the old way.

In stations using lines of shafting it is not uncommon to find six h. p. per dynamo needed to bring the empty machines up to speed, with the belts drawn up as tight as when carrying the load. This, of course, applies to stations where dynamos and shafting are on the same floor, for in those belting from shafting on one floor to dynamos above, the friction is not as much, for obvious reasons. In the "L. P. & D." system, however, the same results are secured as in the last method. The system is the invention of Mr. W. E. Laird of Montpelier, Vt., and the machines are being built and installed by Messrs. Perry and Demerritt, of the same city, who are selling them on approval. They guarantee them to transmit ten per cent. more power with less strain in the bearings, and with a belt of the same width, than any other method of driving now in use. The cost is said not to exceed that of any other system, where the dynamos can be operated independently of each other.



Laird System of Driving Dynamos.

THE HYER-SHEEHAN MOTOR.

We illustrate on this page a very good type of small motor, in the design that has just been put upon the market by the Hyer-Sheehan Electric Motor Co., of Newburgh, N. Y., whose agents for New England are the Redding Electric Co., of Boston. The motor is now being built in four sizes, namely, one-twelfth, one-eighth, one-sixth and one-half h. p.; and the general design is the same throughout the series. Taking the one-twelfth h. p. as an example, it may be stated that all the running parts, except the commutator, are enclosed by the iron frame and are thus protected from injury. The lower half of each bearing is integral with the bedplate, and solidity, strength and smooth running are thus ensured. The armature is a modification of the drum pattern, with projecting teeth, by means of which it is run with a lessened air gap and a consequent greater intensity of field of force. The teeth of the armature hold the coils rigidly in position. The discs of the armature core are stamped from the softest charcoal iron, and the winding is insulated by fibre, so as to prevent any "ground." The field consists of but one coil, wound in a mold and then bound with tape. It is very accessible. The commutator is made of tempered copper with mica insulation, held on a brass sleeve by nuts which press on the beveled ends of the bars. As a general thing the motors are fitted with carbon brushes, whose pressure is kept constant by a spring. The whole motor weighs 12 lbs. It runs at a speed of 2,200 revolutions. The half h. p., a very solid, massive-looking little machine, weighs 80 lbs. and runs at 1,800. All the four sizes are built for 110 and 220 volts constant potential circuits, and for 6½ or 10 ampere arc circuits.

Half Horse Power Hyer-Sheehan Motor.

Mr. W. A. Fitzgerald, superintendent and manager of the Detroit Electric Light & Power Co., is to superintend the electrical exhibit at the next Detroit Exposition.

EXPERIMENTS WITH ALTERNATE CURRENTS OF VERY HIGH FREQUENCY AND THEIR APPLICATION TO METHODS OF ARTIFICIAL ILLUMINATION.[1]

BY NIKOLA TESLA.

THERE is no subject more captivating, more worthy of study, than nature. To understand this great mechanism, to discover the forces which are active, and the laws which govern them, is the highest aim of the intellect of man.

Nature has stored up in the universe infinite energy. The eternal recipient and transmitter of this infinite energy is the ether. The recognition of the existence of ether, and of the functions it performs, is one of the most important results of modern scientific research. The mere abandoning of the idea of action at a distance, the assumption of a medium pervading all space and connecting all gross matter, has freed the minds of thinkers of an ever-present doubt, and, by opening a new horizon—new and unforeseen possibilities—has given fresh interest to phenomena with which we are familiar of old. It has been a great step towards the understanding of the forces of nature and their multifold manifestations to our senses. It has been for the enlightened student of physics what the understanding of the mechanism of the firearm or of the steam engine was for the barbarian. Phenomena upon which we used to look as wonders baffling explanation, we now see in a different light. The spark of an induction coil, the glow of an incandescent lamp, the manifestations of the mechanical forces of currents and magnets are no longer beyond our grasp; instead of the incomprehensible, as before, their observation suggests now in our minds a simple mechanism, and although as to its precise nature all is still conjecture, yet we know that the truth cannot be much longer hidden, and instinctively we feel that the understanding is dawning upon us. We still admire these beautiful phenomena, these strange forces, but we are helpless no longer; we can in a certain measure explain them, account for them, and we are hopeful of finally succeeding in unraveling the mystery which surrounds them.

In how far we can understand the world around us is the ultimate thought of every student of nature. The coarseness of our senses prevents us from recognizing the ulterior construction of matter, and astronomy, this grandest and most positive of natural sciences, can only teach us something that happens, as it were, in our immediate neighborhood: of the remoter portions of the boundless universe, with its numberless stars and suns, we know nothing. But far beyond the limit of perception of our senses the spirit still can guide us, and so we may hope, that even these unknown worlds—infinitely small and great—may in a measure become known to us. Still, even if this knowledge should reach us, the searching mind will find a barrier, perhaps forever unsurpassable, to the *true* recognition of that which *seems* to be, the mere *appearance* of which is the only and slender basis of all our philosophy.

Of all the forms of nature's immeasurable, all-pervading energy, which ever and ever changing and moving, like a soul animates the inert universe, those of electricity and magnetism are perhaps the most fascinating. The effects of gravitation, of heat and light we observe daily, and soon we get accustomed to them, and soon they lose for us the character of the marvelous and wonderful; but electricity and magnetism, with their singular relationship, with their seemingly dual character, unique among the forces in nature, with their phenomena of attractions, repulsions and rotations, strange manifestations of mysterious agents, stimulate and excite the mind to thought and research. What is electricity, and What is magnetism? These questions have been asked again and again. The most able intellects have ceaselessly wrestled with the problem; still the question has not as yet been fully answered. But while we cannot even to-day state what these singular forces are, yet we have made good headway towards the solution of the problem. We are now confident that electric and magnetic phenomena are attributable to ether, and we are perhaps justified in saying, that the effects of static electricity are effects of ether under strain, and those of dynamic electricity and electro-magnetism effects of ether in motion. But this still leaves the question, as to what electricity and magnetism are, unanswered.

First, we naturally inquire, What is electricity, and is there such a thing as electricity? In interpreting electric phenomena, we may speak of electricity or of an electric condition, state or effect. If we speak of electric effects, we must distinguish two such effects, opposite in character and neutralizing each other, as observation shows that two such opposite effects exist. This is unavoidable, for in a medium of the properties of ether, we cannot possibly exert a strain, or produce a displacement or motion of any kind, without causing in the surrounding medium an equivalent and opposite effect. But if we speak of electricity, meaning a *thing*, we must, I think, abandon the idea of two electricities, as the existence of two such things is highly improbable. For how can we imagine that there should be two things, equivalent in amount, alike in their properties, but of opposite character, both clinging to matter, both attracting and completely neutralizing each other? Such an assumption, though suggested by many phenomena, though most convenient for explaining them, has little to commend it. If there *is* such a thing as electricity, there can be only *one* such thing, and, excess and want of that one thing, possibly; but more probably its condition determines the positive and negative character. The old theory of Franklin, though falling short in some respects, is, from a certain point of view, after all, the most plausible one. Still, in spite of this, the theory of the two electricities is generally accepted, as it apparently explains electric phenomena in a more satisfactory manner. But a theory which better explains the facts is not necessarily true. Ingenious minds will invent theories to suit observation, and almost every independent thinker has his own views on the subject.

It is not with the object of advancing an opinion, but with the desire of acquainting you better with some of the results, which I will describe, to show you the reasoning I have followed, the departures I have made—that I venture to express, in a few words, the views and convictions which have led me to these results.

I adhere to the idea that there is a thing which we have been in the habit of calling electricity. The question is, What is that thing? or, What, of all things, the existence of which we know, have we the best reason to call electricity? We know that it acts like an incompressible fluid; that there must be a constant quantity of it in nature; that it can be neither produced nor destroyed; and, what is more important, the electro-magnetic theory of light and all facts observed teach us that electric and ether phenomena are identical. The idea at once suggests itself, therefore, that electricity might be called ether. In fact, this view has in a certain sense been advanced by Dr. Lodge. His interesting work has been read by everyone and many have been convinced by his arguments. His great ability and the interesting nature of the subject, keep the reader spellbound; but when the impressions fade, one realizes that he has to deal only with ingenious explanations. I must confess, that I cannot believe in two electricities, much less in a doubly-constituted ether. The puzzling behavior of the ether as a solid to waves of light and heat, and as a fluid to the motion of bodies through it, is certainly explained in the most natural and satisfactory manner by assuming it to be in motion, as Sir William Thomson has suggested; but regardless of this, there is nothing which would enable us to conclude with certainty that, while a fluid is not capable of transmitting transverse vibrations of a few hundred or thousand per second, it might not be capable of transmitting such vibrations when they range into hundreds of million millions per second. Nor can anyone prove that there are transverse ether waves emitted from an alternate current machine, giving a small number of alternations per second; to such slow disturbances, the ether, if at rest, may behave as a true fluid.

Returning to the subject, and bearing in mind that the existence of two electricities is, to say the least, highly improbable, we must remember, that we have no evidence of electricity, nor can we hope to get it, unless gross matter is present. Electricity, therefore, cannot be called ether in the broad sense of the term; but nothing would seem to stand in the way of calling electricity ether associated with matter, or bound ether; or, in other words, that the so-called static charge of the molecule is ether associated in some way with the molecule. Looking at it in that light, we would be justified in saying, that electricity is concerned in all molecular actions.

Now, precisely what the ether surrounding the molecules is, wherein it differs from ether in general, can only be conjectured. It cannot differ in density, ether being incompressible; it must, therefore, be under some strain or in motion, and the latter is the most probable. To understand its functions, it would be necessary to have an exact idea of the physical construction of matter, of which, of course, we can only form a mental picture.

But of all the views on nature, the one which assumes one matter and one force, and a perfect uniformity throughout, is the most scientific and most likely to be true. An infinitesimal world, with the molecules and their atoms spinning and moving in orbits, in much the same manner as celestial bodies, carrying with them and probably spinning with them ether, or in other words, carrying with them static charges, seems to my mind the most probable view, and one which, in a plausible manner, accounts for most of the phenomena observed. The spinning of the molecules and their ether sets up ether tensions or electrostatic strains; the equalization of ether tensions sets up ether motions or electric currents,

1. A lecture delivered before the American Institute of Electrical Engineers, at Columbia College, N. Y., May 20, 1891.

and the orbital movements produce the effects of electro and permanent magnetism.

About fifteen years ago, Prof. Rowland demonstrated a most interesting and important fact, namely, that a static charge carried around produces the effects of an electric current. Leaving out of consideration the precise nature of the mechanism, which produces the attraction and repulsion of currents, and conceiving the electrostatically charged molecules in motion, this experimental fact gives us a fair idea of magnetism. We can conceive lines or tubes of force which physically exist, being formed of rows of directed moving molecules; we can see that these lines must be closed; that they must tend to shorten and expand, etc. It likewise explains in a reasonable way, the most puzzling phenomenon of all, permanent magnetism, and, in general, has all the beauties of the Ampere theory without possessing the vital defect of the same, namely, the assumption of molecular currents. Without enlarging further upon the subject, I would say, that I look upon all electrostatic, current and magnetic phenomena as being due to electrostatic molecular forces.

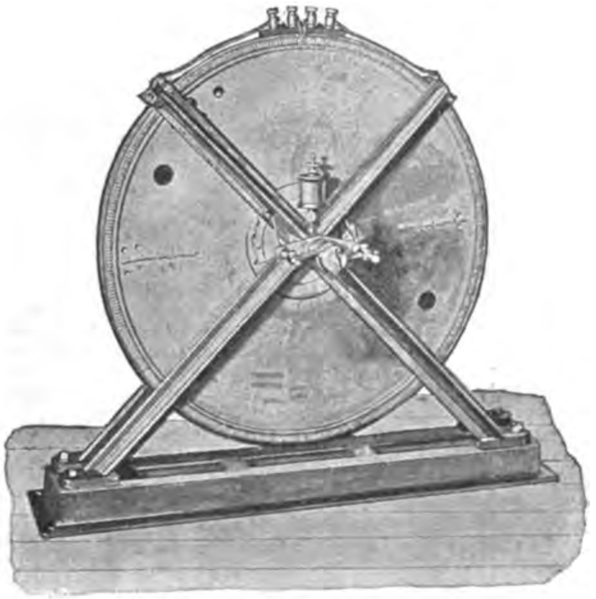


FIG. 1.—HIGH FREQUENCY ALTERNATOR WITH DRUM ARMATURE.

The preceding remarks I have deemed necessary to a full understanding of the subject as it presents itself to my mind.

Of all these phenomena the most important to study are the current phenomena, on account of the already extensive and ever-growing use of currents for industrial purposes. It is now a century since the first practical source of current has been produced, and, ever since, the phenomena which accompany the flow of currents have been diligently studied, and through the untiring efforts of scientific men the simple laws which govern them have been discovered. But these laws were found to hold good only when the currents are of a steady character When the currents are rapidly varying in strength, quite different phenomena, often unexpected, present themselves, and quite different laws hold good, which even now have not been determined as fully as is desirable, though through the work, principally of English scientists, enough knowledge has been gained on the subject to enable us to treat simple cases which now present themselves in daily practice.

The phenomena which are peculiar to the changing character of the currents are greatly exalted when the rate of change is increased, hence the study of these currents is considerably facilitated by the employment of properly constructed apparatus. It was with this and other objects in view that I constructed alternate current machines capable of giving more than two million reversals of current per minute, and to this circumstance it is principally due, that I am able to bring to your attention some of the results thus far reached, which I hope will prove to be a step in advance on account of their direct bearing upon one of the most important problems, namely, the production of a practical and efficient source of light.

The study of such rapidly alternating currents is very interesting. Nearly every experiment discloses something new. Many results may, of course, be predicted, but many more are unforeseen. The experimenter makes many interesting observations. For instance, we take a piece of iron and hold it against a magnet. Starting from low alternations and running up higher and higher we feel the impulses succeed each other faster and faster, get weaker and weaker, and finally disappear. We then observe a continuous pull; the pull, of course, is not continuous; it only appears so to us; our sense of touch is imperfect.

We may next establish an arc between the electrodes and observe as the alternations rise, that the note which accompanies alternating arcs gets shriller and shriller, gradually weakens, and finally ceases. The air vibrations, of course, continue, but they are too weak to be perceived; our sense of hearing fails us.

We observe the small physiological effects, the rapid heating of the iron cores and conductors, curious inductive effects, interesting condenser phenomena, and still more interesting light phenomena with a high tension induction coil. All these experiments and observations would be of the greatest interest to the student, but their description would lead me too far from the principal subject. Partly for this reason, and partly on account of the vastly greater importance, I will confine myself to the description of the light effects produced by these currents.

In the experiments to this end a high tension induction coil or equivalent apparatus for converting currents of comparatively low into currents of high tension is used.

If you will be sufficiently interested in the results I shall describe as to enter into an experimental study of this subject; if you will be convinced of the truth of the arguments I shall advance, your aim will be to produce high frequencies and high potentials; in other words, powerful electrostatic effects. You will then encounter many difficulties, which, if completely overcome, would allow us to produce truly wonderful results.

First will be met the difficulty of obtaining the required frequencies by means of mechanical apparatus, and, if they be obtained otherwise, obstacles of a different nature will present themselves. Next it will be found difficult to provide the requisite insulation without considerably increasing the size of the apparatus, for the potentials required are high, and, owing to the rapidity of the alternations, the insulation presents peculiar difficulties. So, for instance, when a gas is present, the discharge may work, by the molecular bombardment of the gas and consequent heating, through as much as an inch of the best solid insulating material, such as glass, hard rubber, porcelain, sealing wax, etc.; in fact, through any known insulating substance. The chief requisite in the insulation of the apparatus is, therefore, the exclusion of any gaseous matter.

In general my experience tends to show that bodies which possess the highest specific inductive capacity, such as glass, afford a rather inferior insulation to others, which, while they are good insulators, have a much smaller specific inductive capacity, such as oils, for instance, the dielectric losses being no doubt greater in the former. The difficulty of insulating, of course, only exists when the potentials are excessively high, for with potentials such as a few thousand volts there is no particular difficulty encountered in conveying currents from a machine giving, say, 20,000 alternations per second, to quite a distance. This number of alternations, however, is by far too small for many purposes, though quite sufficient for some practical applications. This difficulty of insulating is fortunately not a vital drawback; it affects mostly the size of the apparatus, for, when excessively high potentials would be used, the light-giving devices would be located not far from the apparatus, and often they would be quite close to it. As the air-bombardment of the insulated wire is

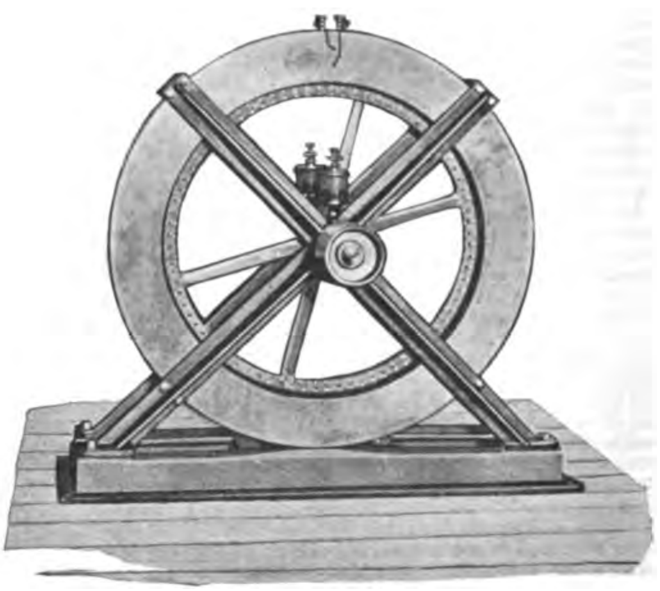


FIG. 2.—HIGH FREQUENCY ALTERNATOR WITH REVOLVING DISC ARMATURE.

dependent on condenser action, the loss may be reduced to a trifle by using excessively thin wires heavily insulated.

Another difficulty will be encountered in the capacity and self-induction necessarily possessed by the coil. If the coil be large, that is, if it contain a great length of wire, it will be generally unsuited for excessively high frequencies; if it be small, it may be well adapted for such frequencies, but the potential might then not be as high as desired. A good insulator, and preferably one possessing a small specific inductive capacity, would afford a two-fold advantage. First, it would enable us to construct a very small coil capable of withstanding enormous differences of potential; and secondly, such a small coil, by reason of its smaller capacity and self-induction, would be capable of a quicker and more vigorous vibration. The problem then of constructing a coil or induction apparatus of any kind possessing the requisite qualities I regard as one of no small importance, and it has occupied me for a considerable time.

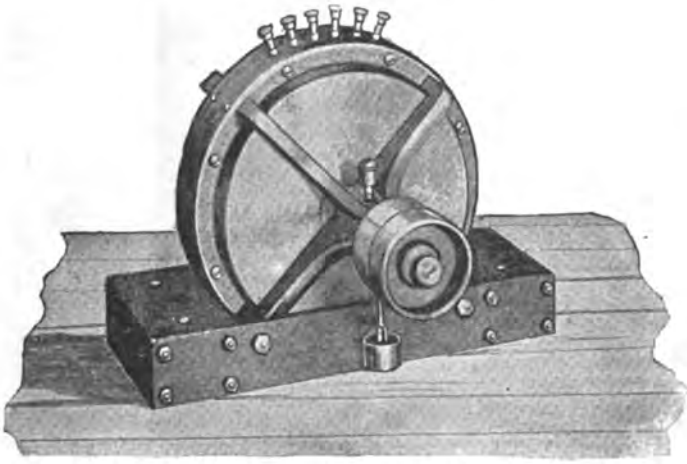


FIG. 3.—HIGH FREQUENCY ALTERNATOR WITH STATIONARY DISC ARMATURE AND STATIONARY EXCITING COIL.

The investigator who desires to repeat the experiments which I will describe, with an alternate current machine, capable of supplying currents of the desired frequency, and an induction coil, will do well to take the primary coil out and mount the secondary in such a manner as to be able to look through the tube upon which the secondary is wound. He will then be able to observe the streams which pass from the primary to the insulating tube, and from their intensity he will know how far he can strain the coil. Without this precaution he is sure to injure the insulation. This arrangement permits, however, an easy exchange of the primaries, which is desirable in these experiments.

The selection of the type of machine best suited for the purpose, must be left to the judgment of the experimenter. There are here illustrated three distinct types of machines, which, besides others, I have used in my experiments.

Fig. 1 represents the machine used in my experiments before this Institute. The field, magnet consists of a ring of wrought iron with 384 pole projections. The armature comprises a steel disc to which is fastened a thin, carefully welded rim of wrought iron. Upon the rim are wound several layers of fine, well annealed iron wire, which, when wound, is passed through shellac. The armature wires are wound around brass pins, wrapped with silk thread The diameter of the armature wire in this type of machine should not be more than ¼ of the thickness of the pole projections, else the local action will be considerable.

Fig. 2 represents a larger machine of a different type. The field-magnet of this machine consists of two like parts which either enclose an exciting coil, or else are independently wound. Each part has 480 pole projections, the projections of one facing those of the other. The armature consists of a wheel of hard bronze, carrying the conductors which revolve between the projections of the field magnet. To wind the armature conductors, I have found it most convenient to proceed in the following manner: I construct a ring of hard bronze of the required size. This ring and the rim of the wheel are provided with the proper number of pins, and both fastened upon a plate. The armature conductors being wound, the pins are cut off and the ends of the conductors fastened by two rings which screw to the bronze ring and the rim of the wheel respectively. The whole may then be taken off and forms a solid structure. The conductors in such a type of machine should consist of sheet copper, the thickness of which, of course, depends on the thickness of the pole projections; or else twisted thin wires should be employed.

Fig. 3 is a smaller machine, in many respects similar to the former, only here the armature conductors and the exciting coil are kept stationary, while only a block of wrought iron is revolved.

It would be uselessly lengthening this description were I to dwell more on the details of construction of these machines. Besides, they have been described somewhat more elaborately in THE ELECTRICAL ENGINEER, of March 18, 1891. I deem it well, however, to call the attention of the investigator to two things, the importance of which, though self evident, he is nevertheless apt to underestimate; namely, to the local action in the conductors which must be carefully avoided, and to the clearance which must be small. I may add, that since it is desirable to use very high peripheral speeds, the armature should be of very large diameter in order to avoid impracticable belt speeds. Of the several types of these machines which have been constructed by me, I have found that the type illustrated in Fig. 1 caused me the least trouble in construction, as well as in maintenance, and, on the whole, it has been a good experimental machine.

In operating an induction coil with very rapidly alternating currents, among the first luminous phenomena noticed are naturally those presented by the high-tension discharge. As the number of alternations per second is increased, or as—the number being high—the current through the primary is varied, the discharge gradually changes in appearance. It would be difficult to describe the minor changes which occur, and the conditions which bring them about, but one may note five distinct forms of the discharge.

First, one may observe a weak, sensitive discharge in the form of a thin, feeble-colored thread. (Fig. 4.) It always occurs when, the number of alternations per second being high, the current through the primary is very small. In spite of the excessively small current, the rate of change is great, and the difference of potential at the terminals of the secondary is therefore considerable, so that the arc is established at great distances; but the quantity of "electricity" set in motion is insignificant, barely sufficient to maintain a thin, threadlike arc. It is excessively sensitive and may be made so to such a degree that the mere act of breathing near the coil will affect it, and unless it is perfectly well protected from currents of air, it wriggles around constantly. Nevertheless, it is in this form excessively persistent, and when the terminals are approached to, say, one-third of the striking distance, it can be blown out only with difficulty. This exceptional persistency, when short, is largely due to the arc being excessively thin; presenting, therefore, a very small surface to the blast. Its great sensitiveness, when very long, is probably due to the motion of the particles of dust suspended in the air.

When the current through the primary is increased, the discharge gets broader and stronger, and the effect of the capacity of the coil becomes visible until, finally, under proper conditions, a white flaming arc, Fig. 5, often as thick as one's finger, and striking across the whole coil, is produced. It develops remarkable heat, and may be further characterized by the absence of the high note which accompanies the less powerful discharges. To take a shock from the coil under these conditions would not be advisable, although under different conditions, the potential being much higher, a shock from the coil may be taken with impunity To produce this kind of discharge the number of alternations per

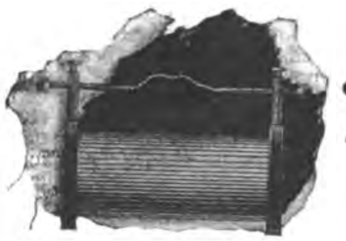


FIG. 4.—SENSITIVE THREAD DISCHARGE.

FIG. 5.—FLAMING DISCHARGE.

second must not be too great for the coil used; and, generally speaking, certain relations between capacity, self-induction and frequency must be observed.

The importance of these elements in an alternate current circuit is now well-known, and, under ordinary conditions, the general rules are applicable. But in an induction coil exceptional conditions prevail. First, the self-induction is of little importance before the arc is established, when it asserts itself, but perhaps never as prominently as in ordinary alternate current circuits, because capacity is distributed all along the coil, and by reason of the fact that the coil usually discharges through very great resistances; hence the currents are exceptionally small. Secondly, the capacity goes on increasing continually as the potential rises, in consequence of absorption which takes place to a considerable extent. Owing to this there exists no critical relationship between these quantities, and ordinary rules would not seem to be applicable. As the potential is increased either in consequence of the increased frequency or of the increased current through the primary, the amount of the energy stored becomes greater and greater, and the capacity gains more and more in importance. Up to a certain point the capacity is beneficial, but after that it begins to be an enormous drawback. It follows from this that each coil gives the best result with a given frequency and primary current. A very large coil, when operated with currents of very high frequency, may not give as much as ¼ inch spark. By adding capacity to the terminals, the condition may be improved, but what the coil really wants is a lower frequency.

When the flaming discharge occurs, the conditions are evidently such that the greatest current is made to flow through the circuit. These conditions may be attained by varying the frequency within wide limits, but the highest frequency at which the flaming arc can still be produced, determines, for a given primary current, the maximum striking distance of the coil. In the flaming discharge the *éclat* effect of the capacity is not perceptible; the rate at which the energy is being stored then just equals the rate at which it can be disposed of through the circuit. This kind of discharge is the severest test for a coil; the break, when it occurs, is of the nature of that in an overcharged Leyden jar. To give a rough approximation I would state that, with an ordinary coil of, say 10,000 ohms resistance, the most powerful arc would be produced with about 12,000 alternations per second.

When the frequency is increased beyond that rate, the potential, of course, rises, but the striking distance may, nevertheless, diminish, paradoxical as it may seem. As the potential rises the coil attains more and more the properties of a static machine until, finally, one may observe the beautiful phenomenon of the streaming discharge, Fig. 6, which may be produced across the whole length of the coil. At that stage streams begin to issue freely from all points and projections. These streams will also be seen to pass in abundance in the space between the primary and the insulating tube. When the potential is excessively high they will always appear, even if the frequency be low, and even if the primary be surrounded by as much as an inch of wax, hard rubber, glass, or any other insulating substance. This limits greatly the output of the coil, but I will later show how I have been able to overcome to a considerable extent this disadvantage in the ordinary coil.

Besides the potential, the intensity of the streams depends on the frequency; but if the coil be very large they show themselves, no matter how low the frequencies used. For instance, in a very large coil of a resistance of 67,000 ohms, constructed by mesome time ago, they appear with as low as 100 alternations per second and less, the insulation of the secondary being ¾ inch of ebonite. When very intense they produce a noise similar to that produced by the charging of a Holtz machine, but much more powerful, and they emit a strong smell of ozone. The lower the frequency, the more apt they are to suddenly injure the coil, With excessively high frequencies they may pass freely without producing any other effect than to heat the insulation slowly and uniformly.

The existence of these streams shows the importance of constructing an expensive coil so as to permit of one's seeing through the tube surrounding the primary, and the latter should be easily exchangeable; or else the space between the primary and secondary should be completely filled up with insulating material so as to exclude all air. The non-observance of this simple rule in the construction of the commercial coils is responsible for the destruction of many an expensive coil.

At the stage when the streaming discharge occurs, or with somewhat higher frequencies, one may, by approaching the terminals considerably and regulating properly the effect of capacity, produce a veritable spray of small silver-white sparks or a bunch of excessively thin silvery threads (Fig. 7) amidst a powerful brush—each spark or thread possibly corresponding to one alternation. This, when produced under proper conditions, is probably the most beautiful discharge, and when an air blast is directed against it, it presents a singular appearance. The spray of sparks, when received through the body, causes some inconvenience, whereas, when the discharge simply streams, nothing at all is likely to be felt if large conducting objects are held in the hands to protect them from receiving small burns.

If the frequency is still more increased, then the coil refuses to give any spark unless at comparatively small distances, and the fifth typical form of discharge may be observed (Fig. 8). The tendency to stream out and dissipate is then so great that when the brush is produced at one terminal no sparking occurs, even if, as I have repeatedly tried, the hand, or any conducting object, is held within the stream; and, what is more singular, the luminous stream is not at all easily deflected by the approach of a conducting body.

At this stage the streams seemingly pass with the greatest freedom through considerable thicknesses of insulators, and it is particularly interesting to study their behavior. For this purpose it is convenient to connect to the terminals of the coil two metallic spheres which may be placed at any desired distance, Fig. 9. Spheres are preferable to plates, as the discharge can be better observed. By inserting dielectric bodies between the spheres, beautiful discharge phenomena may be observed. If the spheres be quite close and a spark be playing between them, by interposing a thin plate of ebonite between the spheres the spark instantly ceases and the discharge spreads into an intensely luminous circle several inches in diameter, provided the spheres are sufficiently large. The passage of the streams heats, and, after a while, softens, the rubber so much that two plates may be made to stick together in this manner. If the spheres are so far apart that no spark occurs, even if they are far beyond the striking distance, by inserting a thick plate of glass the discharge is instantly induced to pass from the spheres to the glass in the form of luminous streams. It appears almost as though these streams pass *through* the dielectric. In reality this is not the case, as the streams are due to the molecules of the air which are violently agitated in the space between the oppositely charged surfaces of the spheres. When no dielectric other than air is present, the bombardment goes on, but is too weak to be visible; by inserting a dielectric the inductive effect is much increased, and besides, the projected air molecules find an obstacle and the bombardment becomes so intense that the streams become luminous. If by any mechanical means we could effect such a violent agitation of the molecules we could produce the same phenomenon. A jet of air escaping through a small hole under enormous pressure and striking against an insulating substance, such as glass, may be luminous in the dark, and it might be possible to produce phosphorescence of the glass or other insulators in this manner.

The greater the specific inductive capacity of the interposed dielectric, the more powerful the effect produced. Owing to this, the streams show themselves with excessively high potentials even if the glass be as much as one and one-half to two inches thick. But besides the heating due to bombardment, some heating goes on undoubtedly in the dielectric, being apparently greater in glass than in ebonite. I attribute this to the greater specific inductive capacity of the glass, in consequence of which, with the same same potential difference, a greater amount of energy is taken up in it than in rubber. It is like connecting to a battery a copper and a brass wire of the same dimensions. The copper wire, though a more perfect conductor, would heat more by reason of its taking more current. Thus what is otherwise considered a virtue of the glass is here a defect. Glass usually gives way much quicker than ebonite; when it is heated to a certain degree, the discharge suddenly breaks through at one point, assuming then the ordinary form of an arc.

The heating effect produced by molecular bombardment of the dielectric would, of course, diminish as the pressure of the air is increased, and at enormous pressures it would be negligible, unless the frequency would increase correspondingly.

It will be often observed in these experiments that when the spheres are beyond the striking distance, the approach of a glass plate, for instance, may induce the spark to jump between the spheres. This occurs when the capacity of the spheres is somewhat below the critical value which gives the greatest difference of potential at the terminals of the coil. By approaching a dielectric, the specific inductive capacity of the space between the spheres is increased, producing the same effect as if the capacity of the spheres were increased. The potential at the terminals may then rise so high that the air space is cracked. The experiment is best performed with dense glass or mica.

Fig. 6.—Streaming Discharge.

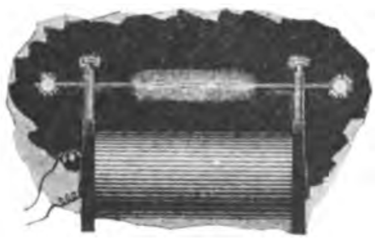


Fig. 7.—Brush and Spray Discharge.

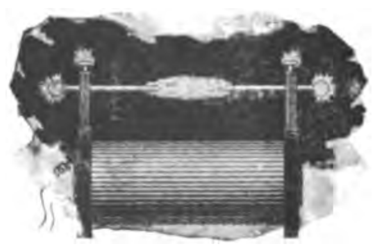


Fig. 8.—Fifth Typical Form of Discharge.

Another interesting observation is that a plate of insulating material, when the discharge is passing through it, is strongly attracted by either of the spheres, that is, by the nearer one, this being obviously due to the smaller mechanical effect of the bombardment on that side, and perhaps also to the greater electrification.

From the behavior of the dielectrics in these experiments we may conclude, that the best insulator for these rapidly alternating currents would be the one possessing the smallest specific inductive capacity and at the same time one capable of withstanding the greatest differences of potential; and thus two diametrically opposite ways of securing the required insulation are indicated, namely, to use either a perfect vacuum or a gas under great pressure; but the former would be preferable. Unfortunately neither of these two ways is easily carried out in practice.

It is especially interesting to note the behavior of an excessively high vacuum in these experiments. If a test tube, provided with external electrodes and exhausted to the highest possible degree, be connected to the terminals of the coil, Fig. 10, the electrodes of the tube are instantly brought to a high temperature and the glass at each end of the tube is rendered intensely phosphorescent, but the middle appears comparatively dark, and for a while remains cool.

When the frequency is so high that the discharge shown in Fig. 8 is observed, considerable dissipation no doubt occurs in the coil. Nevertheless the coil may be worked for a long time, as the heating is gradual.

In spite of the fact that the difference of potential may be enormous, little is felt when the discharge is passed through the body, provided the hands are armed. This is to some extent due to the higher frequency, but principally to the fact that less energy is available externally, when the difference of potential reaches an enormous value, owing to the circumstance that, with the rise of potential, the energy absorbed in the coil increases as the square of the potential. Up to a certain point the energy available externally increases with the rise of potential, then it begins to fall off rapidly. Thus, with the ordinary high tension induction coil, the curious paradox exists, that, while with a given current through the primary the shock might be fatal, with many times that current it might be perfectly harmless, even if the frequency be the same. With high frequencies and excessively high potentials when the terminals are not connected to bodies of some size, practically all the energy supplied to the primary is taken up by the coil. There is no breaking through, no local injury, but all the material, insulating and conducting, is uniformly heated.

To avoid misunderstanding in regard to the physiological effect of alternating currents of very high frequency, I think it

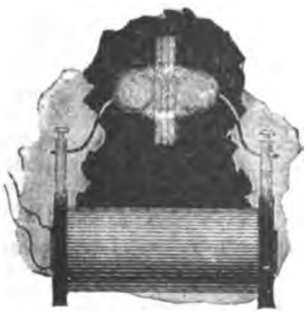


FIG. 9.—LUMINOUS DISCHARGE WITH INTERPOSED INSULATORS.

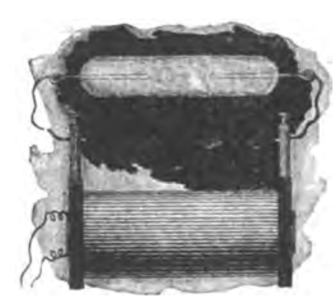


FIG. 10.—DISCHARGE THROUGH HIGHEST VACUUM.

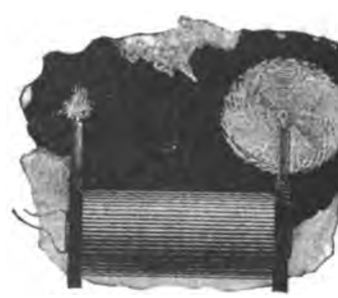


FIG. 11.—PINWHEEL DRIVEN BY A POWERFUL BRUSH.

necessary to state that, while it is an undeniable fact that they are incomparably less dangerous than currents of low frequencies, yet it should not be thought that they are altogether harmless. What has just been said refers only to currents from an ordinary high tension induction coil, which currents are necessarily very small; if received directly from a machine or from a secondary of low resistance, they produce more or less powerful effects, and may cause serious injury, especially when used in conjunction with condensers.

The streaming discharge of a high tension induction coil differs in many respects from that of a powerful static machine. In color it has neither the violet of the positive, nor the brightness of the negative, static discharge, but lies somewhere between, being, of course, alternatively positive and negative. But since the streaming is more powerful when the point or terminal is electrified positively, than when electrified negatively, it follows that the point of the brush is more like the positive, and the root more like the negative, static discharge. In the dark, when the brush is very powerful, the root may appear almost white. The wind produced by the escaping streams, though it may be very strong—often indeed to such a degree that it may be felt quite a distance from the coil—is, nevertheless, considering the quantity of the discharge, smaller than that produced by the positive brush of a static machine, and it affects the flame much less powerfully. From the nature of the phenomenon we can conclude that the higher the frequency, the smaller must, of course, be the wind produced by the streams, and with sufficiently high frequencies no wind at all would be produced at the ordinary atmospheric pressures. With frequencies obtainable by means of a machine, the mechanical effect is sufficiently great to revolve, with considerable speed, large pin-wheels, which in the dark present a beautiful appearance owing to the abundance of the streams (Fig. 11).

In general, most of the experiments usually performed with a static machine can be performed with an induction coil when operated with very rapidly alternating currents. The effects produced, however, are much more striking, being of incomparably greater power. When a small length of ordinary cotton covered wire, Fig. 12, is attached to one terminal of the coil, the streams issuing from all points of the wire may be so intense as to produce a considerable light effect. When the potentials and frequencies are very high, a wire insulated with gutta percha or rubber and attached to one of the terminals, appears to be covered with a luminous film. A very thin bare wire when attached to a terminal emits powerful streams and vibrates continually to and fro or spins in a circle, producing a singular effect (Fig. 13). Some of these experiments have been described by me in *The Electrical World*, of February 21, 1891.

Another peculiarity of the rapidly alternating discharge of the induction coil is its radically different behavior with respect to points and rounded surfaces.

If a thick wire, provided with a ball at one end and with a point at the other, be attached to the positive terminal of a static machine, practically all the charge will be lost through the point, on account of the enormously greater tension, dependent on the radius of curvature. But if such a wire is attached to one of the terminals of the induction coil, it will be observed that with very high frequencies streams issue from the ball almost as copiously as from the point (Fig. 14).

It is hardly conceivable that we could produce such a condition to an equal degree in a static machine, for the simple reason, that the tension increases as the square of the density, which in turn is proportional to the radius of curvature; hence, with a steady potential an enormous charge would be required to make streams issue from a polished ball while it is connected with a point. But with an induction coil the discharge of which alternates with great rapidity, it is different. Here we have to deal with two distinct tendencies. First, there is the tendency to escape which exists in a condition of rest, and which depends on the radius of curvature; second, there is the tendency to dissipate into the surrounding air by condenser action, which depends on the surface. When one of these tendencies is a maximum, the other is at a minimum. At the point the luminous stream is principally due to the air molecules coming bodily in contact with the point; they are attracted and repelled, charged and discharged, and, their atomic charges being thus disturbed, vibrate and emit light waves. At the ball, on the contrary, there is no doubt that the effect is to a great extent produced inductively, the air molecules not *necessarily* coming in contact with the ball, though they undoubtedly do so. To convince ourselves of this we only need to exalt the condenser action, for instance, by enveloping the ball, at some distance, by a better conductor than the surrounding medium, the conductor being, of course, insulated; or else by surrounding it with a better dielectric and approaching an insulated conductor; in both cases the streams will break forth more copiously. Also, the larger the ball with a given frequency, or the higher the frequency, the more will the ball have the advantage over the point. But, since a certain intensity of action is required to render the streams visible, it is obvious that in the experiment described the ball should not be taken too large.

In consequence of this two-fold tendency, it is possible to produce by means of points effects identical to those produced by capacity. Thus, for instance, by attaching to one terminal of the coil a small length of soiled wire, presenting many points and offering great facility to escape, the potential of the coil may be raised to the same value as by attaching to the terminal a polished ball of a surface many times greater than that of the wire.

An interesting experiment, showing the effect of the points, may be performed in the following manner: Attach to one of the terminals of the coil a cotton covered wire about two feet in length,

FIG. 12.—LUMINOUS STREAMS ESCAPING FROM A COTTON-COVERED WIRE.

and adjust the conditions so that streams issue from the wire. In this experiment the primary coil should be preferably placed so that it extends only about half way into the secondary coil. Now touch the free terminal of the secondary with a conducting object held in the hand, or else connect it to an insulated body of some size. In this manner the potential on the wire may be enormously

cule is able to get away, and this the more so, as for a given effect the potential required is smaller; and a frequency is conceivable —perhaps even obtainable—at which practically the same molecules would strike the terminal. Under such conditions the exchange of the molecules would be very slow, and the heat produced at, and very near, the terminal would be excessive. But if the frequency would go on increasing constantly, the heat produced would begin to diminish for obvious reasons. In the positive brush of a static machine the exchange of the molecules is very rapid, the stream is constantly of one direction, and there are fewer collisions; hence the heating effect must be very small. Anything that impairs the facility of exchange tends to increase the local heat produced. Thus, if a bulb be held over the terminal of the coil so as to enclose the brush, the air contained in the bulb is very quickly brought to a high temperature. If a glass tube be held over the brush so as to allow the draught to carry the brush upwards, scorching hot air escapes at the top of the tube. Anything held within the brush is, of course, rapidly heated, and the possibility of using such heating effects for some purpose or other suggests itself.

When contemplating this singular phenomenon of the hot brush, we cannot help being convinced that a similar process must take place in the ordinary flame, and it seems strange that after all these centuries past of familiarity with the flame, now, in this era of electric lighting and heating, we are finally led to recognize, that since time immemorial we have, after all, always had "electric light and heat" at our disposal. It is also of no little interest to contemplate, that we have a possible way of producing —by other than chemical means—a veritable flame, which would give light and heat without any material being consumed, without any chemical process taking place, and to accomplish this, we only need to perfect methods of producing enormous frequencies

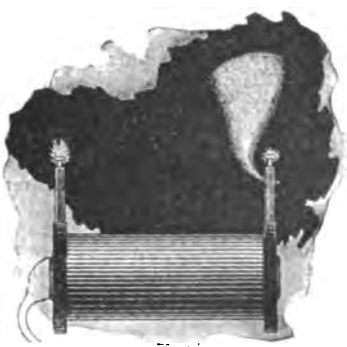


FIG. 13.—ASPECT PRESENTED BY A VERY THIN WIRE ATTACHED TO A TERMINAL OF THE COIL.

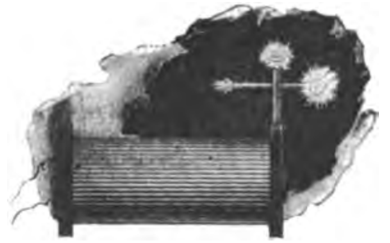


FIG. 14.—EFFECT OF BALL AND POINT.

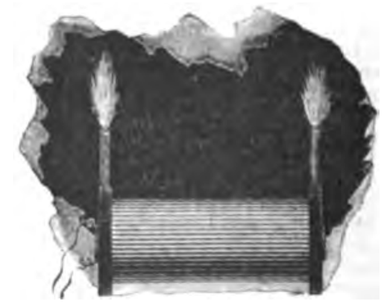


FIG. 15.—ASPECT OF COIL UNDER POWERFUL BRUSH DISCHARGE.

raised. The effect of this will be to either increase, or to diminish, the streams. If they increase, the wire is too short; if they diminish, it is too long. By adjusting the length of the wire, a point is found where the touching of the other terminal does not at all affect the streams. In this case the rise of potential is exactly counteracted by the drop through the coil. It will be observed that small lengths of wire produce considerable difference in the magnitude and luminosity of the streams. The primary coil is placed sidewise for two reasons: First, to increase the potential at the wire and, second, to increase the drop through the coil. The sensitiveness is thus augmented.

There is still another and far more striking peculiarity of the brush discharge produced by very rapidly alternating currents. To observe this it is best to replace the usual terminals of the coil by two metal columns insulated with a good thickness of ebonite. It is also well to close all fissures and cracks with wax so that the brushes cannot form anywhere except at the tops of the columns. If the conditions are carefully adjusted—which, of course, must be left to the skill of the experimenter—so that the potential rises to an enormous value, one may produce two powerful brushes several inches long, nearly white at their roots, which in the dark bear a striking resemblance to two flames of a gas escaping under pressure (Fig. 15). But they do not only *resemble*, they *are* veritable flames, for they are hot. Certainly they are not as hot as a gas burner, *but they would be so if the frequency and the potential would be sufficiently high.* Produced with, say, twenty thousand alternations per second, the heat is easily perceptible even if the potential is not excessively high. The heat developed is, of course, due to the impact of the air molecules against the terminals and against each other. As, at the ordinary pressures, the mean free path is excessively small, it is possible that in spite of the enormous initial speed imparted to each molecule upon coming in contact with the terminal, its progress—by collision with other molecules—is retarded to such an extent, that it does not get away far from the terminal, but may strike the same many times in succession. The higher the frequency, the less the mole-

and potentials. I have no doubt that if the potential could be made to alternate with sufficient rapidity and power, the brush formed at the end of a wire would lose its electrical characteristics and would become flamelike. The flame must be due to electrostatic molecular action.

This phenomenon now explains in a manner which can hardly

FIG. 16.—INCANDESCENT WIRE OR FILAMENT SPINNING IN AN UNEXHAUSTED GLOBE

be doubted the frequent accidents occurring in storms. It is well known that objects are often set on fire without the lightning striking them. We shall presently see how this can happen. On a nail in a roof, for instance, or on a projection of any kind, more or less conducting, or rendered so by dampness, a powerful brush may appear. If the lightning strikes somewhere in the neighborhood the enormous potential may be made to alternate or fluctuate perhaps many million times a second. The air molecules are violently attracted and repelled, and by their impact produce such a powerful heating effect that a fire is started. It is conceivable that a ship at sea may, in this manner, catch fire at many points at once. When we consider, that even with the comparatively low frequencies obtained from a dynamo machine, and with potentials of no more than one or two hundred thousand volts, the heating effects are considerable, we may imagine how much more powerful they must be with frequencies and potentials many times greater, and the above explanation seems, to say the least, very probable. Similar explanations may have been suggested, but I am not aware that, up to present, the heating effects of a brush produced by a rapidly alternating potential have been experimentally demonstrated, at least not to such a remarkable degree.

By preventing completely the exchange of the air molecules the local heating effect may be so exalted as to bring a body to incandescence. Thus, for instance, if a small button, or preferably a very thin wire or filament be enclosed in an unexhausted globe and connected with the terminal of the coil, it may be rendered incandescent. The phenomenon is made much more interesting by the rapid spinning round in a circle of the top of the filament, thus presenting the appearance of a luminous funnel, Fig. 16, which widens when the potential is increased. When the potential is small the end of the filament may perform irregular motions, suddenly changing from one to the other, or it may describe an ellipse; but when the potential is very high it always spins in a circle; and so does generally a thin straight wire attached freely to the terminal of the coil. These motions are, of course, due to the impact of the molecules, and the irregularity in the distribution of the potential, owing to the roughness and dissymmetry of the wire or filament. With a perfectly symmetrical and polished wire such motions would probably not occur. That the motion is not likely to be due to other causes is evident from the fact that it is not of a definite direction, and that in a very highly exhausted globe it ceases altogether. The possibility of

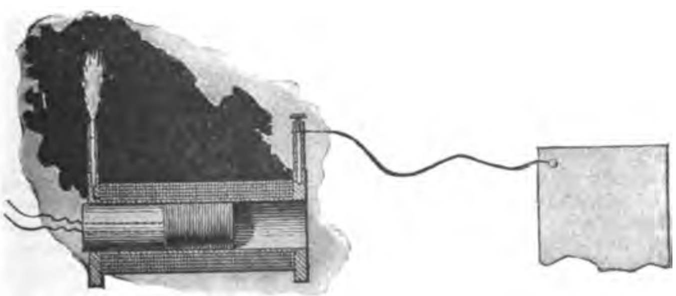


FIG. 17A.—COIL ARRANGED FOR POWERFUL BRUSH EFFECTS.

bringing a body to incandescence in an unexhausted globe, or even when not at all enclosed, would seem to afford a possible way of obtaining light effects, which, in perfecting methods of producing rapidly alternating potentials, might be rendered available for useful purposes.

In employing a commercial coil, the production of very powerful brush effects is attended with considerable difficulties, for when these high frequencies and enormous potentials are used, the best insulation is apt to give way. Usually the coil is insulated well enough to stand the strain from convolution to convolution, since two double silk covered paraffined wires will withstand a pressure of several thousand volts; the difficulty lies principally in preventing the breaking through from the secondary to the primary, which is greatly facilitated by the streams issuing from the latter. In the coil, of course, the strain is greatest from section to section, but usually in a larger coil there are so many sections that the danger of a sudden giving way is not very great. No difficulty will generally be encountered in that direction, and besides, the liability of injuring the coil internally is very much reduced by the fact that the effect most likely to be produced is simply a gradual heating, which, when far enough advanced, could not fail to be observed. The principal necessity is then to prevent the streams between the primary and the tube, not only on account of the heating and possible injury, but also because the streams may diminish very considerably the potential difference available at the terminals. A few hints as to how this may be accomplished will probably be found useful in most of these experiments with the ordinary induction coil.

One of the ways is to wind a short primary, Fig. 17 A, so that the difference of potential is not at that length great enough to cause the breaking forth of the streams through the insulating tube. The length of the primary should be determined by experiment. Both the ends of the coil should be brought out on one end through a plug of insulating material fitting in the tube as illustrated. In such a disposition one terminal of the secondary is attached to a body the surface of which is determined with the greatest care so as to produce the greatest rise in the potential. At the other terminal a powerful brush appears, which may be experimented upon.

The above plan necessitates the employment of a primary of comparatively small size, and it is apt to heat when powerful effects are desirable for a certain length of time. In such a case it is better to employ a larger coil, Fig. 17 B, and introduce it from one side of the tube, until the streams begin to appear. In this case the nearest terminal of the secondary may be connected to the primary or to the ground, which is practically the same

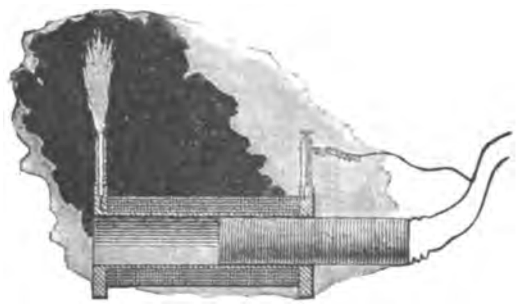


FIG. 17B.—COIL ARRANGED FOR POWERFUL BRUSH EFFECTS.—ST. ELMO'S HOT FIRE.

thing, if the primary is connected directly to the machine. In the case of ground connections it is well to determine experimentally the frequency which is best suited under the conditions of the test. Another way of obviating the streams, more or less, is to make the primary in sections and supply it from separate well insulated sources.

In many of these experiments, when powerful effects are wanted for a short time, it is advantageous to use iron cores with the primaries. In such case a very large primary coil may be wound and placed side by side with the secondary, and, the nearest terminal of the latter being connected to the primary, a laminated iron core is introduced through the primary into the secondary as far as the streams will permit. Under these conditions an excessively powerful brush, several inches long, which may be appropriately called "St. Elmo's hot fire," may be caused to appear at the other terminal of the secondary, producing striking effects. It is a most powerful ozonizer, so powerful indeed, that only a few minutes are sufficient to fill the whole room with the smell of ozone, and it undoubtedly possesses the quality of exciting chemical affinities.

For the production of ozone, alternating currents of very high frequency are eminently suited, not only on account of the advantages they offer in the way of conversion but also because of the fact, that the ozonizing action of a discharge is dependent on the frequency as well as on the potential, this being undoubtedly confirmed by observation.

In these experiments if an iron core is used it should be carefully watched, as it is apt to get excessively hot in an incredibly short time. To give an idea of the rapidity of the heating, I will state, that by passing a powerful

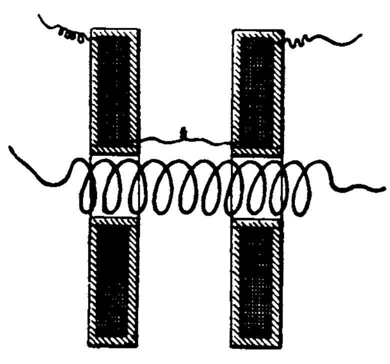


FIG. 18.—COIL FOR PRODUCING VERY HIGH DIFFERENCE OF POTENTIAL.

current through a coil with many turns, the inserting within the same of a thin iron wire for no more than one second's time is sufficient to heat the wire to something like 100° C.

But this rapid heating does not need to discourage us in the use of iron cores in connection with rapidly alternating currents. I have for a long time been convinced, that in the industrial distribution by means of transformers, some such plan as the following might be practicable. We may use a comparatively small iron core, subdivided, or perhaps not even subdivided. We may surround this core with a considerable thickness of material which is fire-proof and conducts the heat poorly, and on top of that we may place the primary and secondary windings. By using either higher frequencies or greater magnetizing forces, we may by hysteresis and eddy currents heat the iron core so far as to bring it nearly to its maximum permeability, which, as Hopkinson has shown, may be as much as sixteen times greater than that at ordinary temperatures. If the iron core were perfectly enclosed it would not be deteriorated by the heat, and, if the enclosure of fire-proof materi l would be sufficiently thick, only a limited amount of energy could be radiated in spite of the high temperature. Transformers have been constructed by me on that plan, but for lack of time, no thorough tests have as yet been made.

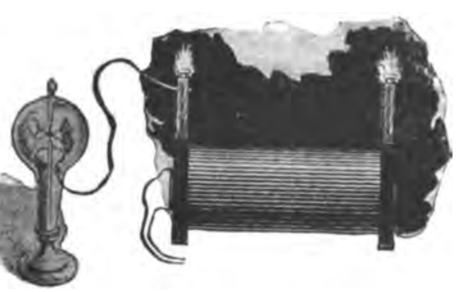


FIG. 19.—THE CROOKES EXPERIMENT ON OPEN CIRCUIT.

Another way of adapting the iron core to rapid alternations, or, generally speaking, reducing the frictional losses, is to produce by continuous magnetization a flow of something like seven thousand or eight thousand lines per square centimetre through the core, and then work with weak magnetizing forces and preferably high frequencies around the point of greatest permeability. A higher efficiency of conversion and greater output are obtainable in this manner. I have also employed this principle in connection with machines in which there is no reversal of polarity. In these types of machines, as long as there are only few pole projections, there is no great gain, as the maxima and minima of magnetization are far from the point of maximum permeabilty; but when the number of the pole projections is very great, the required rate of change may be obtained, without the magnetization varying so far as to depart greatly from the point of maximum permeability, and the gain is considerable.

The above described arrangements refer only to the use of commercial coils as ordinarily constructed. If it is desired to construct a coil for the express purpose of performing with it such experiments as I have described, or, generally, rendering it capable of withstanding the greatest possible difference of potential, then a construction as indicated in Fig. 18 will be found of advantage. The coil in this case is formed of two independent parts which are wound oppositely, the connection between both being made near the primary. The potential in the middle being zero, there is not much tendency to jump to the primary and not much insulation is required. In some cases, the middle point may, however, be connected to the primary or to the ground. In such a coil the places of greatest difference of potential are far apart and the coil is capable of withstanding an enormous strain. The two parts may be movable so as to allow a slight adjustment of the capacity effect.

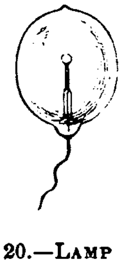


FIG. 20.—LAMP WITH SINGLE BLOCK OF REFRACTORY MATERIAL.

As to the manner of insulating the coil, it will be found convenient to proceed in the following way: First the wire should be boiled in paraffine, until all the air is out; then the coil is wound by running the wire through melted paraffine, merely for the purpose of fixing the wire. The coil is then taken off from the spool, immersed in a cylindrical vessel filled with pure melted wax and boiled for a long time until the bubbles cease to appear. The whole is then left to cool down thoroughly, and then the mass is taken out of the vessel and turned up in a lathe. A coil made in this manner and with care is capable of withstanding enormous potential differences.

It may be found convenient to immerse the coil in paraffine oil or some other kind of oil; it is a most effective way of insulating, principally on account of the perfect exclusion of air, but it may be found that, after all, a vessel filled with oil is not a very convenient thing to handle in a laboratory.

If an ordinary coil can be dismounted, the primary may be taken out of the tube and the latter plugged up on one end, filled with oil, and the primary reinserted. This affords an excellent insulation and prevents the formation of the streams.

Of all the experiments which may be performed with rapidly alternating currents the most interesting are those which concern the production of a practical illuminant. It cannot be denied, that the present methods, though they were billiant advances, are very wasteful. Some better methods must be invented, some more perfect apparatus devised. Modern research has opened new possibilities for the production of an efficient source of light, and the attention of all has been turned in the direction indicated by able pioneers. Many have been carried away by the enthusiasm and passion to discover, but in their zeal to reach results, many have been misled. Starting with the idea of producing electro-magnetic waves, they turned their attention, perhaps, too much to the study of electro-magnetic effects, and neglected the study of electrostatic phenomena. Naturally, nearly every investigator availed himself of an apparatus similar to that used in earlier experiments. But in those forms of apparatus, while the electro-magnetic inductive effects are enormous, the electrostatic effects are excessively small.

In the Hertz experiments, for instance, a high tension induction coil is short circuited by an arc, the resistance of which is very small, the smaller, the more capacity is attached to the terminals; and the difference of potential at these is enormously

FIG. 21.—LAMP WITH TWO FILAMENTS IN HIGHEST VACUUM WITH LEADING-IN WIRES.

diminished. On the other hand, when the discharge is not passing between the terminals, the static effects may be considerable, but only qualitatively so, not quantitatively, since their rise and fall is very sudden, and since their frequency is small. In neither case, therefore, are powerful electrostatic effects perceivable. Similar conditions exist when, as in some interesting experiments of Dr. Lodge, Leyden jars are discharged disruptively. It has been thought—and I believe asserted—that in such cases most of the energy is radiated into space. In the light of the experiments, which I have described above, it will now not be thought so I feel safe in asserting, that in such cases most of the energy is partly taken up and converted into heat in the arc of the discharge and in the conducting and insulating material of the jar, some energy being, of course, given off by electrification of the air; but the amount of the directly radiated energy is very small.

When a high tension induction coil, operated by currents alternating only 20,000 times a second, has its terminals closed through even a very small jar, practically all the energy passes through the dielectric of the jar, which is heated, and the electrostatic effects manifest themselves outwardly only to a very weak degree. Now the external circuit of a Leyden jar, that is, the arc and the connections of the coatings may be looked upon as a circuit generating alternating currents of excessively high frequency and fairly high potential, which is closed through the coatings and the dielectric between them, and from the above it is evident that the external electrostatic effects must be very small, even if a recoil circuit be used. These conditions make it appear, that with the apparatus usually at hand the observation of powerful electrostatic effects was impossible, and what experience has been gained in that direction is only due to the great ability of the investigators.

But powerful electrostatic effects are a *sine qua non* of light production on the lines indicated by theory. Electro-magnetic effects are primarily unavailable, for the reason that to produce the required effects we would have to pass current impulses through a conductor which, long before the required frequency of the impulses could be reached, would cease to transmit them. On the other hand, electro-magnetic waves many times longer than those of light, and producible by sudden discharges of a condenser, could not be utilized, it would seem, except we avail ourselves of their effect upon conductors as in the present methods, which are wasteful. We could not affect by means of such waves the static molecular or atomic charges of a gas, cause them to vibrate and to emit light. Long transverse waves cannot, apparently, produce such effects, since excessively small electro-magnetic disturbances may pass readily through miles of air. Such dark waves, unless they are of the length of true light waves, cannot, it would seem, excite luminous radiation in a Geissler tube, and the luminous effects, which are producible by induction in a tube devoid of electrodes, I am inclined to consider as being of an electrostatic nature.

FIG. 22.—LAMP WITH TWO REFRACTORY BLOCKS IN HIGHEST VACUUM.

To produce such luminous effects, straight electrostatic thrusts are required; these, whatever be their frequency, may disturb the molecular charges and produce light. Since current impulses of the required frequency cannot pass through a conductor of measurable dimensions, we must work with a gas, and then the production of powerful electrostatic effects becomes an imperative necessity.

It has occurred to me, however, that electrostatic effects are in many ways available for the production of light. For instance, we may place a body of some refractory material in a closed, and preferably more or less exhausted, globe, connect it to a source of high, rapidly alternating, potential, causing the molecules of the gas to strike it many times a second at enormous speeds, and in this manner, with trillions of invisible hammers, pound it until it gets incandescent; or, we may place a body in a very highly exhausted globe, in a non-striking vacuum, and, by employing very high frequencies and potentials, transfer sufficient energy from it to other bodies in the vicinity, or in general to the surroundings, to maintain it at any degree of incandescence; or, we may, by means of such rapidly alternating high potentials, disturb the ether carried by the molecules of a gas or their static charges, causing them to vibrate and to emit light.

But, electrostatic effects being dependent upon the potential and frequency, to produce the most powerful action it is desirable to increase both as far as practicable. It may be possible to obtain quite fair results by keeping either of these factors small, provided the other is sufficiently great; but we are limited in both directions. My experience demonstrates that we cannot go below a certain frequency, for, first, the potential then becomes so great that it is dangerous; and, secondly, the light production is less efficient.

I have found that, by using the ordinary low frequencies, the physiological effect of the current required to maintain at a certain degree of brightness a tube four feet long, provided at the ends with outside and inside condenser coatings, is so powerful that, I think, it might produce serious injury to those not accustomed to such shocks; whereas, with twenty thousand alternations per second, the tube may be maintained at the same degree of brightness without any effect being felt. This is due principally to the fact that a much smaller potential is required to produce the same light effect, and also to the higher efficiency in the light production. It is evident that the efficiency in such cases is the greater, the higher the frequency, for the quicker the process of charging and discharging the molecules, the less energy will be lost in the form of dark radiation. But, unfortunately, we cannot go beyond a certain frequency on account of the difficulty of producing and conveying the effects.

I have stated above, that a body enclosed in an unexhausted bulb may be intensely heated by simply connecting it with a source of rapidly alternating potential. The heating in such a case is, in all probability, due mostly to the bombardment of the molecules of the gas contained in the bulb. When the bulb is exhausted the heating of the body is much more rapid, and there is no difficulty whatever in bringing a wire or filament to any degree of incandescence by simply connecting it to one terminal of a coil of the proper dimensions. Thus, if the well-known apparatus of Prof. Crookes, consisting of a bent platinum wire with vanes mounted over it (Fig. 19), be connected to one terminal of the coil—either one or both ends of the platinum wire being connected—the wire is rendered almost instantly incandescent and the mica vanes are rotated as though a current from a battery were used. A thin carbon filament, or, preferably, a button of some refractory material (Fig. 20), even if it be a comparatively poor conductor, enclosed in an exhausted globe, may be rendered highly incandescent; and in this manner a simple lamp capable of giving any desired candle-power is provided.

The success of lamps of this kind would depend largely on the selection of the light-giving bodies contained within the bulb. Since, under the conditions described, refractory bodies—which are very poor conductors and capable of withstanding for a long time excessively high degrees of temperature—may be used, such illuminating devices may be rendered successful.

It might be thought at first that if the bulb, containing the filament or button of refractory material, be perfectly well exhausted—that is, as far as it can be done by the use of the best apparatus—the heating would be much less intense, and that in a perfect vacuum it could not occur at all. This is not confirmed by my experience; quite the contrary, the better the vacuum the more easily the bodies are brought to incandescence. This result is interesting for many reasons.

At the outset of this work the idea presented itself to me, whether two bodies of refractory material enclosed in a bulb exhausted to such a degree that the discharge of a large induction coil, operated in the usual manner, cannot pass through, could be rendered incandescent by mere condenser action. Obviously, to reach this result enormous potential differences and very high frequencies are required, as is evident from a simple calculation.

But such a lamp would possess a vast advantage over an ordinary incandescent lamp in regard to efficiency. It is well-known

FIG. 23.—LAMP WITH SINGLE STRAIGHT FILAMENT AND ONE LEADING-IN WIRE.

that the efficiency of a lamp is to some extent a function of the degree of incandescence, and that, could we but work a filament at many times higher degrees of incandescence, the efficiency would be much greater. In an ordinary lamp this is impracticable on account of the destruction of the filament, and it has been determined by experience how far it is advisable to push the incandescence. It is impossible to tell how much higher efficiency could be obtained if the filament could withstand indefinitely, as the investigation to this end obviously cannot be carried beyond a certain stage; but there are reasons for believing that it would be very considerably higher. An improvement might be made in the ordinary lamp by employing a short and thick carbon;

but then the leading-in wires would have to be thick, and, besides, there are many other considerations which render such a modification entirely impracticable. But in a lamp as above described, the leading-in wires may be very small, the incandescent refractory material may be in the shape of blocks offering a very small radiating surface, so that less energy would be required to keep them at the desired incandescence; and in addition to this, the refractory material need not be carbon, but may be manufactured from mixtures of oxides, for instance, with carbon or other material, or may be selected from bodies which are practically non-

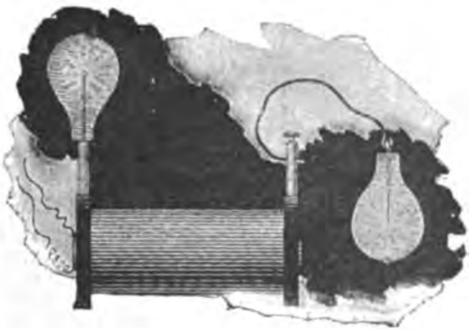


FIG. 24.—LAMPS WITH ONE LEADING-IN WIRE RENDERED INCANDESCENT.

conductors, and capable of withstanding enormous degrees of temperature.

All this would point to the possibility of obtaining a much higher efficiency with such a lamp than is obtainable in ordinary lamps. In my experience it has been demonstrated that the blocks are brought to high degrees of incandescence with much lower potentials than those determined by calculation, and the blocks may be set at greater distances from each other. We may freely assume, and it is probable, that the molecular bombardment is an important element in the heating, even if the globe be exhausted with the utmost care as I have done; for although the number of the molecules is, comparatively speaking, insignificant, yet on account of the mean free path being very great, there are fewer collisions, and the molecules may reach much higher speeds, so that the heating effect due to this cause may be considerable, as in the Crookes experiments with radiant matter.

But it is likewise possible that we have to deal here with an increased facility of losing the charge in very high vacuum, when the potential is rapidly alternating, in which case most of the heating would be directly due to the surging of the charges in the heated bodies. Or else the observed fact may be largely attributable to the effect of the points which I have mentioned above, in consequence of which the blocks or filaments contained in the vacuum are equivalent to condensers of many times greater surface than that calculated from their geometrical dimensions. Scientific men still differ in opinion as to whether a

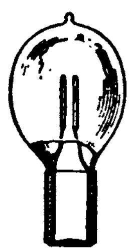


FIG. 25.—LAMP WITH TWO BLOCKS OR FILAMENTS AND A PAIR OF INDEPENDENT INSIDE AND OUTSIDE CONDENSER COATINGS.

charge should, or should not, be lost in a perfect vacuum, or in other words, whether ether is, or is not, a conductor. If the former were the case, then a thin filament enclosed in a perfectly exhausted globe, and connected to a source of enormous, steady potential, would be brought to incandescence.

Various forms of lamps on the above described principle, with the refractory bodies in the form of filaments, Fig. 21, or blocks, Fig. 22, have been constructed and operated by me, and investigations are being carried on in this line. There is no difficulty in reaching such high degrees of incandescence that ordinary carbon is to all appearance melted and volatilized. If the vacuum could be made absolutely perfect, such a lamp, although inoperative with apparatus ordinarily used, would, if operated with currents of the required character, afford an illuminant which would never be destroyed, and which would be far more efficient than an ordinary incandescent lamp. This perfection can, of course, never be reached, and a very slow destruction and gradual diminution of the size always occurs, as in incandescent lamps; but there is no possibility of a sudden and premature disabling which occurs in the latter by the breaking of the filament, especially when the incandescent bodies are in the shape of blocks.

With these rapidly alternating potentials there is, however, no necessity of enclosing two blocks in a globe, but a single block, as in Fig. 20, or filament, Fig. 23, may be used. The potential in this case must of course be higher, but it is easily obtainable, and besides it is not necessarily dangerous.

The facility with which the button or filament in such a lamp is brought to incandescence, other things being equal, depends on the size of the globe. If a perfect vacuum could be obtained, the size of the globe would not be of importance, for then the heating would be wholly due to the surging of the charges, and all the energy would be given off to the surroundings by radiation. But this can never occur in practice. There is always some gas left in the globe, and although the exhaustion may be carried to the highest degree, still the space inside of the bulb must be considered as conducting when such high potentials are used, and I assume that, in estimating the energy that may be given off from the filament to the surroundings, we may consider

FIG. 26A.

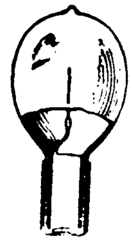


FIG. 26B.

LAMP WITH ONE FILAMENT, ONE INSIDE AND ONE OUTSIDE CONDENSER COATING.

the inside surface of the bulb as one coating of a condenser, the air and other objects surrounding the bulb forming the other coating. When the alternations are very low there is no doubt that a considerable portion of the energy is given off by the electrification of the surrounding air.

In order to study this subject better, I carried on some experiments with excessively high potentials and low frequencies. I then observed that when the hand is approached to the bulb,—the filament being connected with one terminal of the coil,—a powerful vibration is felt, being due to the attraction and repulsion of the molecules of the air which are electrified by induction through the glass. In some cases when the action is very intense I have been able to hear a sound, which must be due to the same cause.

When the alternations are low, one is apt to get an excessively powerful shock from the bulb. In general, when one attaches bulbs or objects of some size to the terminals of the coil, one should look out for the rise of potential, for it may happen that by merely connecting a bulb or plate to the terminal, the potential may rise to many times its original value. When lamps are attached to the terminals, as illustrated in Fig. 24, then the capacity of the bulbs should be such as to give the maximum rise of potential under the existing conditions. In this manner one may obtain the required potential with fewer turns of wire.

The life of such lamps as described above depends, of course, largely on the degree of exhaustion, but to some extent also on the shape of the block of refractory material. Theoretically it would seem that a small sphere of carbon enclosed in a sphere of glass would not suffer deterioration from molecular bombardment, for, the matter in the globe being radiant, the molecules would move in straight lines, and would seldom strike the sphere obliquely. An interesting thought in connection with such a lamp is, that in it "electricity" and electrical energy apparently must move in the same lines.

The use of alternating currents of very high frequency makes it possible to transfer, by electrostatic or electromagnetic induction through the glass of a lamp, sufficient energy to keep a filament at incandescence and so do away with the leading-in wires. Such lamps have been proposed, but for want of proper apparatus they have not been successfully operated. Many forms of lamps on this principle with continuous and broken filaments have been constructed by me and experimented upon. When using a secondary enclosed within the lamp, a condenser is advantageously combined with the scondary. When the transference is effected by electrostatic induction, the potentials used are, of course, very high with frequencies obtainable from a machine. For instance, with a condenser surface of forty centimetres square, which is not impracticably large, and with glass of good quality 1 mm. thick, using currents alternating twenty thousand times a second, the potential required is approximately 9,000 volts. This may seem large, but since each lamp may be included in the secondary of a transformer of very small dimensions, it would not be inconvenient, and, moreover, it would not produce fatal injury. The transformers would all be preferably in series. The regulation would offer no difficulties, as with currents of such frequencies it is very easy to maintain a constant current.

In the accompanying engravings some of the types of lamps of this kind are shown. Fig. 25 is such a lamp with a broken filament, and Fig. 26 A and 26 B one with a single outside and inside coating and a single filament. I have also made lamps with two outside and inside coatings and a continuous loop connecting the latter. Such lamps have been operated by me with current impulses of the enormous frequencies obtainable by the disruptive discharge of condensers.

The disruptive discharge of a condenser is especially suited for operating such lamps—with no outward electrical connections—by means of electromagnetic induction, the electromagnetic inductive effects being excessively high; and I have been able to produce the desired incandescence with only a few short turns of wire. Incandescence may also be produced in this manner in a simple closed filament.

Leaving now out of consideration the practicability of such lamps, I would only say that they possess a beautiful and desirable feature, namely, that they can be rendered, at will, more or less brilliant simply by altering the relative position of the outside and inside condenser coatings, or inducing and induced circuits.

FIG. 27.—LAMP WITH ONE FILAMENT AND LEADING-IN WIRE AND EXTERNAL CONDENSER COATING.

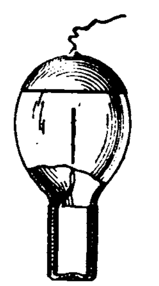


FIG. 28.—LAMP WITH ONE FILAMENT, ONE INSIDE AND ONE OUTSIDE CONDENSER COATING, AND AUXILIARY COATING.

When a lamp is lighted by connecting it to one terminal only of the source, this may be facilitated by providing the globe with an outside condenser coating, which serves at the same time as a reflector, and connecting this to an insulated body of some size. Lamps of this kind are illustrated in Fig. 27 and Fig. 28. Fig. 29 shows the plan of connections. The brilliancy of the lamp may, in this case, be regulated within wide limits by varying the size of the insulated metal plate to which the coating is connected.

It is likewise practicable to light with one leading wire lamps such as illustrated in Fig. 21 and Fig. 22, by connecting one terminal of the lamp to one terminal of the source, and the other to an insulated body of the required size. In all cases the insulated body serves to give off the energy into the surrounding space, and is equivalent to a return wire. Obviously, in the two last-named cases, instead of connecting the wires to an insulated body, connections may be made to the ground.

The experiments which will prove most suggestive and of most interest to the investigator are probably those performed with exhausted tubes. As might be anticipated, a source of such rapidly alternating potentials is capable of exciting the tubes at a considerable distance, and the light effects produced are remarkable.

During my investigations in this line I endeavored to excite tubes, devoid of any electrodes, by electromagnetic induction, making the tube the secondary of the induction device, and passing through the primary the discharges of a Leyden jar. These tubes were made of many shapes, and I was able to obtain luminous effects which I then thought were due wholly to electromagnetic induction. But on carefully investigating the phenomena I found that the effects produced were more of an electrostatic nature. It may be attributed to this circumstance that this mode of exciting tubes is very wasteful, namely, the primary circuit being closed, the potential, and consequently the electrostatic inductive effect, is much diminished.

FIG. 29.—INCREASING THE BRILLIANCY OF LAMP ON ONE WIRE.

When an induction coil, operated as above described, is used, there is no doubt that the tubes are excited by electrostatic induction, and that electromagnetic induction has little, if anything, to do with the phenomena.

This is evident from many experiments. For instance, if a tube be taken in one hand, the observer being near the coil, it is brilliantly lighted and remains so no matter in what position it is held relatively to the observer's body. Were the action electromagnetic, the tube could not be lighted when the observer's body is interposed between it and the coil, or at least its luminosity should be considerably diminished. When the tube is held exactly over the centre of the coil—the latter being wound in sections and the primary placed symmetrically to the secondary—it may remain completely dark, whereas it is rendered intensely luminous by moving it slightly to the right or left from the centre of the coil. It does not light because in the middle both halves of the coil neutralize each other, and the electric potential is zero. If the action were electromagnetic, the tube should light best in the plane through the centre of the coil, since the electromagnetic effect there should be a maximum. When an arc is established between the terminals, the tubes and lamps in the vicinity of the coil go out, but light up again when the arc is broken, on account of the rise of potential. Yet the electromagnetic effect should be practically the same in both cases.

By placing a tube at some distance from the coil, and nearer to one terminal—preferably at a point on the axis of the coil—one may light it by touching the remote terminal with an insulated body of some size or with the hand, thereby raising the potential at that terminal nearer to the tube. If the tube is shifted nearer to the coil so that it is lighted by the action of the nearer terminal, it may be made to go out by holding, on an insulated support, the end of a wire connected to the remote terminal, in the vicinity of the nearer terminal, by this means counteracting the action of the latter upon the tube. These effects are evidently electrostatic. Likewise, when a tube is placed at a considerable distance from the coil, the observer may, standing upon an insulated support, between coil and tube, light the latter by approaching the hand to it; or he may even render it luminous by simply stepping between it and the coil. This would be impossible with electromagnetic induction, for the body of the observer would act as a screen.

When the coil is energized by excessively weak currents, the experimenter may, by touching one terminal of the coil with the tube, extinguish the latter, and may again light it by bringing it out of contact with the terminal and allowing a small arc to form. This is clearly due to the respective lowering and raising of the potential at that terminal. In the above experiment, when the tube is lighted through a small arc, it may go out when the arc is broken, because the electrostatic inductive effect alone is too weak, though the potential may be much higher; but when the arc is established, the electrification of the end of the tube is much greater, and it consequently lights.

If a tube is lighted by holding it near to the coil, and in the hand which is remote, by grasping the tube anywhere with the other hand, the part between the hands is rendered dark, and the singular effect of wiping out the light of the tube may be produced by passing the hand quickly along the tube and at the same time withdrawing it gently from the coil, judging properly the distance so that the tube remains dark afterwards.

If the primary coil is placed sidewise, as in Fig. 17 B for instance, and an exhausted tube be introduced from the other side in the hollow space, the tube is lighted most intensely because of the increased condenser action, and in this position the striæ are most sharply defined. In all these experiments described, and in many others, the action is clearly electrostatic.

The effects of screening also indicate the electrostatic nature of the phenomena and show something of the nature of electrification through the air. For instance, if a tube be placed in the direction of the axis of the coil, and an insulated metal plate be interposed, the tube will generally increase in brilliancy, or if it be too far from the coil to light, it may even be rendered luminous by interposing an insulated metal plate. The magnitude of the effects depends to some extent on the size of the plate. But if the metal plate be connected by a wire to the ground, its interposition will always make the tube go out even if it be very near the coil. In general, the interposition of a body between the coil and tube, increases or diminishes the brilliancy of the tube, or its facility to light up, according to whether it increases or diminishes the electrification. When experimenting with an insulated plate, the plate should not be taken too large, else it will generally produce a weakening effect by reason of its great facility for giving off energy to the surroundings.

If a tube be lighted at some distance from the coil, and a plate of hard rubber or other insulating substance be interposed, the tube may be made to go out. The interposition of the dielectric in this case only slightly increases the inductive effect, but diminishes considerably the electrification through the air.

field. For this purpose I suspend a sheet of metal a distance from the ceiling on insulating cords and connect it to one terminal of the induction coil, the other terminal being preferably connected to the ground. Or else I suspend two sheets as illustrated in Fig. 30, each sheet being connected with one of the terminals of the coil, and their size being carefully determined. An exhausted tube may then be carried in the hand anywhere between the sheets or placed anywhere, even a certain distance beyond them; it remains always luminous.

In such an electrostatic field interesting phenomena may be observed, especially if the alternations are kept low and the potentials excessively high. In addition to the luminous phenomena mentioned, one may observe that any insulated conductor gives sparks when the hand or another object is approached to it, and the sparks may often be powerful. When a large conducting object is fastened on an insulating support, and the hand approached to it a vibration, due to the rythmical motion of the air molecules is felt, and luminous streams may be perceived when the hand is held near a pointed projection. When a telephone receiver is made to touch with one or both of its terminals an insulated conductor of some size, the telephone emits a loud sound; it also emits a sound when a length of wire is attached to one or both terminals, and with very powerful fields a sound may be perceived even without any wire.

How far this principle is capable of practical application, the future will tell. It might be thought that electrostatic effects are unsuited for such action at a distance. Electromagnetic inductive effects, if available for the production of light, might be thought better suited. It is true the electrostatic effects diminish nearly with the cube of the distance from the coil, whereas the electromagnetic inductive effects diminish simply with the distance. But when we establish an electrostatic field of force, the condition is very different, for then, instead of the differential effect of both the terminals, we get their conjoint effect. Besides, I would call attention to the fact, that in an alternating electrostatic field, a conductor, such as an exhausted tube, for instance, tends to take up most of the energy, whereas in an electromagnetic alternating field the conductor tends to take up the least energy, the waves being reflected with but little loss. This is one reason why it is difficult to excite an exhausted tube, at a distance, by electromagnetic induction. I have wound coils of very large diameter and of many turns of wire, and connected a Geissler tube to the ends of the coil with the object of exciting the tube at a distance; but even with the powerful inductive effects producible by Leyden jar discharges, the tube could not be excited unless at a very small distance, although some judgment was used as to the dimensions of the coil. I have also found that even the most powerful Leyden jar discharges are capable of exciting only feeble luminous effects in a closed exhausted tube, and even these effects upon thorough examination I have been forced to consider of an electrostatic nature.

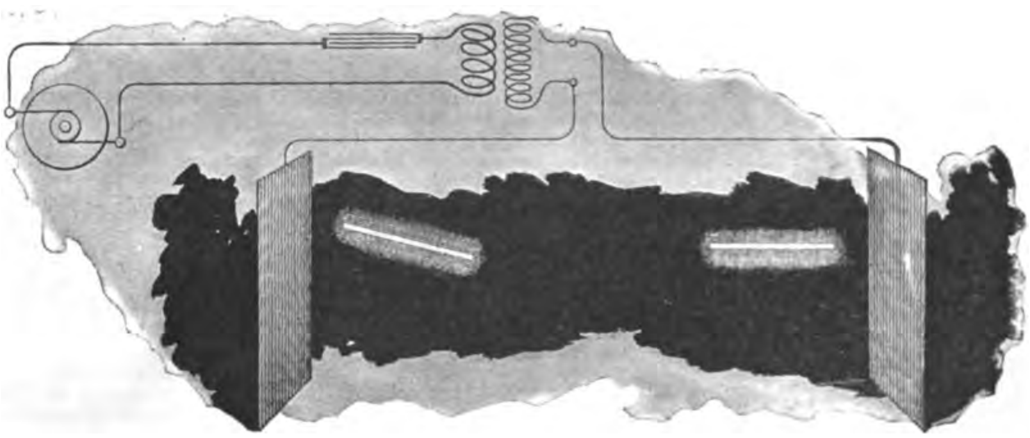


FIG. 30.—IDEAL METHOD OF LIGHTING A ROOM.—TUBES DEVOID OF ANY ELECTRODES RENDERED BRILLIANT IN AN ALTERNATING ELECTROSTATIC FIELD.

In all the cases, then, when we excite luminosity in exhausted tubes by means of such a coil, the effect is due to the rapidly alternating electrostatic potential; and, furthermore, it must be attributed to the harmonic alternation produced directly by the machine, and not to any superimposed vibration which might be thought to exist. Such superimposed vibrations are impossible when we work with an alternate current machine. If a spring be gradually tightened and released, it does not perform independent vibrations; for this a sudden release is necessary. So with the alternate currents from a dynamo machine; the medium is harmonically strained and released, this giving rise to only one kind of waves; a sudden contact or break, or a sudden giving way of the dielectric, as in the disruptive discharge of a Leyden jar, are essential for the production of superimposed waves.

In all the last described experiments, tubes devoid of any electrodes may be used, and there is no difficulty in producing by their means sufficient light to read by. The light effect is, however, considerably increased by the use of phosphorescent bodies such as yttria, uranium glass, etc. A difficulty will be found when the phosphorescent material is used, for with these powerful effects, it is carried gradually away, and it is preferable to use material in the form of a solid.

Instead of depending on induction at a distance to light the tube, the same may be provided with an external—and, if desired, also with an internal—condenser coating, and it may then be suspended anywhere in the room from a conductor connected to one terminal of the coil, and in this manner a soft illumination may be provided.

The ideal way of lighting a hall or room would, however, be to produce such a condition in it that an illuminating device could be moved and put anywhere, and that it is lighted, no matter where it is put and without being electrically connected to anything. I have been able to produce such a condition by creating in the room a powerful, rapidly alternating electrostatic

How then can we hope to produce the required effects at a distance by means of electromagnetic action, when even in the closest proximity to the source of disturbance, under the most advantageous conditions, we can excite but faint luminosity? It is true that when acting at a distance we have the resonance to help us out. We can connect an exhausted tube, or whatever the illuminating device may be, with an insulated system of the proper capacity, and so it may be possible to increase the effect qualitatively, and only qualitatively, for we would not get *more* energy through the device. So we may, by resonance effect, obtain the required electromotive force in an exhausted tube, and excite faint luminous effects, but we cannot get enough energy to render the light practically available, and a simple calculation, based on experimental results, shows that even if all the energy which a tube would receive at a certain distance from the source should be wholly converted into light, it would hardly satisfy the practical requirements. Hence the necessity of directing, by means of a conducting circuit, the energy to the place of transformation. But in so doing we cannot very sensibly depart from present methods, and all we could do would be to improve the apparatus.

From these considerations it would seem that if this ideal way of lighting is to be rendered practicable it will be only by the use of electrostatic effects. In such a case the most powerful electrostatic inductive effects are needed; the apparatus employed must, therefore, be capable of producing high electrostatic potentials changing in value with extreme rapidity. High frequencies are

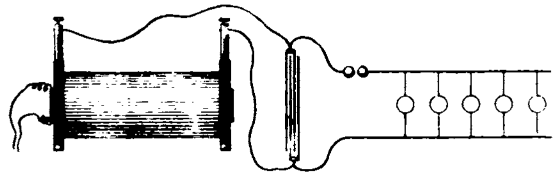


FIG. 31.—DIAGRAM OF CONNECTIONS FOR CONVERTING FROM HIGH TO LOW TENSION BY MEANS OF THE DISRUPTIVE DISCHARGE.

especially wanted, for practical considerations make it desirable to keep down the potential. By the employment of machines, or, generally speaking, of any mechanical apparatus, but low frequencies can be reached; recourse must, therefore, be had to some other means. The discharge of a condenser affords us a means of obtaining frequencies by far higher than are obtainable mechanically, and I have accordingly employed condensers in the experiments to the above end.

When the terminals of a high tension induction coil, Fig. 31, are connected to a Leyden jar, and the latter is discharging disruptively into a circuit, we may look upon the arc playing between the knobs as being a source of alternating, or generally speaking, undulating currents, and then we have to deal with the familiar system of a generator of such currents, a circuit connected to it, and a condenser bridging the circuit. The condenser in such case is a veritable transformer, and since the frequency is excessive, almost any ratio in the strength of the currents in both the branches may be obtained. In reality the analogy is not quite complete, for in the disruptive discharge we have most generally a fundamental instantaneous variation of comparatively low frequency, and a superimposed harmonic vibration, and the laws governing the flow of currents are not the same for both.

In converting in this manner, the ratio of conversion should not be too great, for the loss in the arc between the knobs increases with the square of the current, and if the jar be discharged through very thick and short conductors, with the view of obtaining a very rapid oscillation, a very considerable portion of the energy stored is lost. On the other hand, too small ratios are not practicable for many obvious reasons.

As the converted currents flow in a practically closed circuit, the electrostatic effects are necessarily small, and I therefore convert them into currents or effects of the required character. I have effected such conversions in several ways. The preferred plan of connections is illustrated in Fig. 32. The manner of operating renders it easy to obtain by means of a small and inexpensive apparatus enormous differences of potential which have been

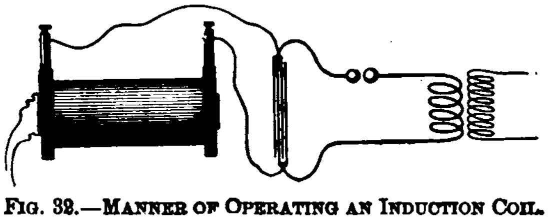


FIG. 32.—MANNER OF OPERATING AN INDUCTION COIL.

usually obtained by means of large and expensive coils. For this it is only necessary to take an ordinary small coil, adjust to it a condenser and discharging circuit, forming the primary of an auxiliary small coil, and convert upward. As the inductive effect of the primary currents is excessively great, the second coil need have comparatively but very few turns. By properly adjusting the elements, remarkable results may be secured.

In endeavoring to obtain the required electrostatic effects in this manner, I have, as might be expected, encountered many difficulties which I have been gradually overcoming, but I am not as yet prepared to dwell upon my experiences in this direction.

I believe that the disruptive discharge of a condenser will play an important part in the future, for it offers vast possibilities, not only in the way of producing light in a more efficient manner and in the line indicated by theory, but also in many other respects.

For years the efforts of inventors have been directed towards obtaining electrical energy from heat by means of the thermopile. It might seem invidious to remark that but few know what is the real trouble with the thermopile. It is not the inefficiency or small output—though these are great drawbacks—but the fact that the thermopile has its phylloxera, that is, that by constant use it is deteriorated, which has thus far prevented its introduction on an industrial scale. Now that all modern research seems to point with certainty to the use of electricity of excessively high tension, the question must present itself to many whether it is not possible to obtain in a practicable manner this form of energy from heat. We have been used to look upon an electrostatic machine as a plaything, and somehow we couple with it the idea of the inefficient and impractical. But now we must think differently, for now we know that everywhere we have to deal with the same forces, and that it is a mere question of inventing proper methods or apparatus for rendering them available.

In the present systems of electrical distribution, the employment of the iron with its wonderful magnetic properties allows us to reduce considerably the size of the apparatus; but, in spite of this, it is still very cumbersome. The more we progress in the study of electric and magnetic phenomena, the more we become convinced that the present methods will be short-lived. For the production of light, at least, such heavy machinery would seem

FIG. 33.—LAMP KEPT AT INCANDESCENCE ACROSS A THICK COPPER BAR—SHOWING NODES.

to be unnecessary. The energy required is very small, and if light can be obtained as efficiently as, theoretically, it appears possible, the apparatus need have but a very small output. There being a strong probability that the illuminating methods of the future will involve the use of very high potentials, it seems very desirable to perfect a contrivance capable of converting the energy of heat into energy of the requisite form. Nothing to speak of has been done towards this end, for the thought that electricity of some 50,000 or 100,000 volts pressure or more, even if obtained, would be unavailable for practical purposes, has deterred inventors from working in this direction.

In Fig. 31 a plan of connections is shown for converting currents of high, into currents of low, tension by means of the disruptive discharge of a condenser. This plan has been used by me frequently for operating a few incandescent lamps required in the laboratory. Some difficulties have been encountered in the arc of the discharge which I have been able to overcome to a great extent; besides this, and the adjustment necessary for the proper working, no other difficulties have been met with, and it was easy to operate ordinary lamps, and even motors, in this manner. The line being connected to the ground, all the wires could be handled with perfect impunity, no matter how high the potential at the terminals of the condenser. In these experiments a high tension induction coil, operated from a battery or from an alternate current machine, was employed to charge the condenser; but the induction coil might be replaced by an apparatus of a different kind, capable of giving electricity of such high tension. In this manner, direct or alternating currents may be converted, and in both cases the current-impulses may be of any desired frequency. When the currents charging the condenser are of the same direction, and it is desired that the converted currents should also be of one direction, the resistance of the discharging circuit should, of course, be so chosen that there are no oscillations.

In operating devices on the above plan I have observed curious phenomena of impedance which are of interest. For instance if a thick copper bar be bent, as indicated in Fig. 33, and shunted by ordinary incandescent lamps, then, by passing the discharge between the knobs, the lamps may be brought to incandescence although they are short-circuited. When a large induction coil is employed it is easy to obtain nodes on the bar, which are rendered evident by the different degree of brilliancy of the lamps, as shown roughly in Fig. 33. The nodes are never clearly defined, but there are simply maxima and minima of potentials along the bar. This is probably due to the irregularity of the arc between the knobs. In general when the above described plan of conversion from high to low tension is used, the behavior of the disruptive discharge may be closely studied. The nodes may also be investigated by means of an ordinary Cardew voltmeter which should be well insulated. Geissler-tubes may also be lighted accross the points of the bent bar; in this case, of course, it is better to employ smaller capacities. I have found it practicable to light up in this manner a lamp, and even a Geissler tube, shunted by a short heavy block of metal, and this result seems at first very curious. In fact, the thicker the copper bar in Fig. 33, the better it is for the success of the experiments, as they appear more striking. When lamps with long slender filaments are used it will be often noted that the filaments are from time to time violently vibrated, the vibration being smallest at the nodal points. This vibration seems to be due to an electrostatic action between the filament and the glass of the bulb.

In some of the above experiments it is preferable to use special lamps having a straight filament as shown in Fig. 34. When such

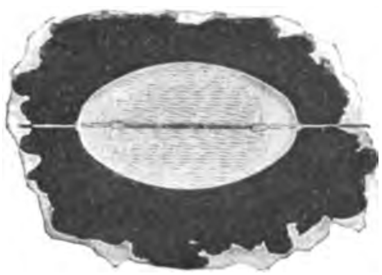


FIG. 34.—PHENOMENON OF IMPEDANCE IN AN INCANDESCENT LAMP.

a lamp is used a still more curious phenomenon than those described may be observed. The lamp may be placed across the copper bar and lighted, and by using somewhat larger capacities, or, in other words, smaller frequencies, or smaller impulsive impedances, the filament may be brought to any desired degree of incandescence. But when the impedance is increased, a point is reached when comparatively little current passes through the carbon, and most of it through the rarefied gas; or perhaps it may be more correct to state that the current divides nearly evenly through both, in spite of the enormous difference in the resistance, and this would be true unless the gas and the filament behave differently. It is then noted that the whole bulb is brilliantly illuminated, and the ends of the leading-in wires become incandescent and often throw off sparks in consequence of the violent bombardment, but the carbon filament remains dark. This is illustrated in Fig. 34. Instead of the filament a single wire extending through the whole bulb may be used, and in this case the phenomenon would seem to be still more interesting.

From the above experiment it will be evident, that when ordinary lamps are operated by the converted currents, those should be preferably taken in which the platinum wires are far apart, and the frequencies used should not be too great, else the discharge will occur at the ends of the filament or in the base of the lamp between the leading-in wires, and the lamp might then be damaged.

In presenting to you these results of my investigation on the subject under consideration, I have paid only a passing notice to facts upon which I could have dwelt at length, and among many observations I have selected only those which I thought most likely to interest you. The field is wide and completely unexplored, and at every step a new truth is gleaned, a novel fact observed.

How far the results here borne out are capable of practical applications will be decided in the future. As regards the production of light, some results already reached are encouraging and make me confident in asserting that the practical solution of the problem lies in the direction I have endeavored to indicate. Still, whatever may be the immediate outcome of these experiments I am hopeful that they will only prove a step to further development towards the ideal and final perfection. The possibilities which are opened by modern research are so vast that even the most reserved must feel sanguine of the future. Eminent scientists consider the problem of utilizing one kind of radiation without the others a rational one. In an apparatus designed for the production of light by conversion from any form of energy into that of light, such a result can never be reached, for no matter what the process of producing the required vibrations, be it electrical, chemical or any other, it will not be possible to obtain the higher light vibrations without going through the lower heat vibrations. It is the problem of imparting to a body a certain velocity without passing through all lower velocities. But there is a possibility of obtaining energy not only in the form of light, but motive power, and energy of any other form, in some more direct way from the medium. The time will be when this will be accomplished, and the time has come when one may utter such words before an enlightened audience without being considered a visionary. We are whirling through endless space with an inconceivable speed, all around us everything is spinning, everything is moving, everywhere is energy. There *must* be some way of availing ourselves of this energy more directly. Then, with the light obtained from the medium, with the power derived from it, with every form of energy obtained without effort, from the store forever inexhaustible, humanity will advance with giant strides. The mere contemplation of these magnificent possibilities expands our minds, strengthens our hopes and fills our hearts with supreme delight.

European Correspondence.

LONDON.

Communication with Lighthouses.—Law Cases.—Making of Phosphorus by Electricity.

YESTERDAY Sir M. Hicks-Beach received at the Board of Trade a deputation from the Associated Chambers of Commerce which asked that a system of telegraphic or telephonic communication might be established between coast-guard and life-boat stations, lighthouses and light-ships, and the general telegraphic system of the country. The memorial which was presented set forth the need for this communication, instancing the wreck of the Schiller, when 331 lives were lost close to the Bishop Lighthouse. The coroner's jury found that had the lighthouse-keepers been able to communicate with the shore, the whole of these 331 lives would have been saved. It was a matter of national importance that means of communicating with the shore should be provided, and it was estimated that this could be done for £100,000. In time of war the information that could be given of the movement of ships would be most valuable to the naval and military authorities. Other countries, such as France, Denmark, Norway, Holland, Sweden, Canada, and the Cape, had their lighthouses connected by telegraph and telephone with the general telegraphic systems of those countries. Sir Michael Hicks-Beach in reply said the movement had his sympathy, but he would recommend them to see the Chancellor of the Exchequer.

Two cases of interest will be brought before the courts at an early date. In one Messrs. Crompton are engaged in an action with Phillips Brothers, the dispute having arisen as to certain wire supplied. The other is the Lane-Fox claims, which will be either finally quashed or upheld.

The Electrical Construction Corporation have begun to make phosphorus by electricity. H. S.

LONDON, June 8, 1891.

City Electric Railway.—The Earth and Electric Railway.—Electric Lighting Orders.

The City Railway Co. yesterday held an extraordinary general meeting for the purpose of raising some additional capital to carry out further extensions.

The chairman, in the course of his remarks, said he considered the working had been satisfactory, seeing that they had had to educate the staff in the new power with which they worked their line. The electrical engines, however, had not been equal to the growing service, and they had ordered new locomotives by which they hoped to improve their service and run the trains more frequently. During the time the line had been opened they had carried 3,000,000 passengers in perfect safety. They were earning an income at the present time at the rate of £40,000 a year, and after meeting all expenses, they estimated that this amount left a profit of £12,000, which, though a small sum, was sufficient to cover their debenture interest and to leave a surplus of £3,000 or £4,000. It was decidedly a cheerful tone adopted by the chairman, and convinced the shareholders that things were in a good condition, but there were one or two rather ominous suggestions for the future dividends of ordinary shareholders. If, as the chairman said, they were able to increase their traffic to the extent of £20,000 a year they could pay a dividend of 3½ per cent. It is difficult to see how this is to be done, for, to increase their income they must extend their line further, and to meet the expense of such an extension it would be necessary to get further capital which would, of course, swallow up any small dividends.

Work in connection with the electric lighting of Dublin has been commenced in real earnest. The building of the central station is going on rapidly, and not many months will elapse before something substantial is the result.

For some months past the Greenwich observations on the earth's magnetic currents have been interfered with in a mysterious manner. This disturbance consists in a continuous vibration of the registering needles, commencing just before seven o'clock in the morning, going all through the day, and terminating shortly after eleven o'clock at night. This went on for a long time on week days only; but on Sunday, the 5th of April, and on every succeeding Sunday up to the present time, the interference has been experienced, from about one o'clock in the afternoon till about 10 P. M. or a little later. It has now been determined that these disturbances are due to the electric railway between Stockwell and the city, corresponding as they do, exactly with the working hours on that line, the Sunday disturbances not beginning until trains were run on that day. The curious part about this phenomena is that the distance between the railway and Greenwich Observatory is about 4 miles. Ferranti's Deptford station is within a few hundred yards.

Some five or more years ago, Mr. Ellis notes, a similar disturbance was registered in the circuit on the south bank of the Thames. The cause was not traced at the time, although it has been conjectured to be in some way connected with the electric "installations" in progress at the time. H. S.

LONDON, June 17, 1891.

Letters to the Editor.

THE PRINCIPLE OF THE WINKLER DYNAMO.

In your issue of June 24th, we notice a cut and description of a new "Universal" dynamo, viz., the Winkler. From the description given, the claim for newness is based upon the fact of the armature having a commutator at each end and wound with two independent windings. We also notice that the inventor claims for the machine that by this means he does away with all sparking, and also dispenses with the use of a rheostat. It is useless, however, to dilate upon the many advantages claimed for the machine, as it is not that question that we wish to discuss—it is the newness of the idea or invention. In the year 1882, Mr. F. A. La Roche, of Philadelphia, constructed several machines of the same general principle, and operated them successfully, doing even more than the Winkler machine will do by running both arc and incandescent lights from the one machine or two separate and distinct circuits; and at times I used the one circuit for charging fields alone. We have now one of our old machines on hand that was built about seven years ago by our firm.

F. A. LA ROCHE.

PHILADELPHIA, PA.

Society and Club Notes.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the regular monthly meeting of the Council of the American Institute of Electrical Engineers, the following delegates were appointed to attend the Frankfort Electrical Conference, in accordance with a resolution adopted at the general meeting, May 21st: Carl Hering, chairman; Prof. R. O. Heinrich, Nikola Tesla, Dr. E. L. Nichols. Prof. Heinrich is already in Europe, and Mr. Hering sailed July 2d on the Normannia.

The following associate members were elected:

Barnard, John H.; general manager, Asheville Street Railway Co., and Asheville Light and Power Co., Asheville, N. C.
Cram, Henry B.; treasurer, Bernstein Electric Co., 175 Prospect street, Cambridgeport, Mass.
Dame, Frank L.; superintendent, Vancouver Electric Railway and Light Co., Vancouver, B. C.
Emery, Charles Edward; consulting engineer, 22 Cortlandt street, New York.
Fay, Thomas J.; Maine Electric Improvement Co., 136 Liberty street, New York.
Fisk, Walter C.; manager, Bernstein Electric Co., 620 Atlantic avenue, Boston, Mass.
Gans, John L.; superintendent and electrician, The Electric Company, Connellsville, Penn.
Hadley, Warren B.; superintendent wiring department, Edison Electric Illuminating Co., 431 Fifth avenue, New York.
Healy, Louis W.; The Wightman Electric Co., 1,205 Marion street, Scranton, Pa.
Kellogg, James W.; assistant to district engineer, Edison General Electric Co., 140 E. 27th street, New York.
Luquee, Thatcher T. P.; assistant in surveying and practical mining, and student in electrical engineering, Columbia College, N. Y. and Bedford, N. Y.
Rosebrugh, Thomas Reeve; lecturer in electrical engineering, School of Practical Science, Toronto, Ont.
Taintor, Giles; assistant electrician, N. E. Telephone and Telegraph Co., 7 Walnut street, Boston, Mass.
Wirt, Herbert C.; electrician, marine department, Thomson-Houston Electric Co., 12 Millmont street, Roxbury, Mass.
Woodward, Francke L., student in electricity, 49 Grand street, Albany, N. Y.

Mr. Jesse M. Smith, was transferred from associate to full membership.

No further meetings of the Institute will be held until September.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.

The annual meeting of this association has now been definitely arranged to be held in this city on August 11, and preparations have been begun by Secretary Jenks. It is expected that the convention will be one of the largest ever held by the association. The Edison General Electric Co. will extend hospitalities to the members by arranging for special trips to the Schenectady and other Edison factories.

Reports of Companies.

AMERICAN BELL TELEPHONE CO.

The Bell Telephone Company has declared a regular quarterly dividend of 3 per cent. and an extra one of 6 per cent. It will take $1,350,000 to pay this dividend. The business of the American Bell Telephone Co. is steadily on the increase. On June 20, 1891, there were 502,953 instruments in licensees' hands under rental, against 483,790 on December 20, 1890, a gain of 19,163; and 465,334 on June 20, 1890, a gain of 36,619, or 8 per cent.

THE EMPIRE CITY ELECTRIC COMPANY.—A VOLUNTARY DISSOLUTION.

On Monday, June 29, the Empire City Electric Company, of New York, applied to the Supreme Court for the appointment of a receiver to liquidate its business, the directors of the company having decided to make a voluntary dissolution. Judge Beach granted the application, and appointed as receiver Charles S. Beardsley, of Yonkers, N. Y. It is stated, in behalf of the company that its business has been conducted at a loss during the past six months. The officers and principal shareholders are unwilling to invest further, and deem a voluntary liquidation the most expedient course to pursue in justice to their creditors and themselves. It is reported that the condition of the company's affairs is such as to indicate that creditors will be paid in full. No statement of assets and liabilities has yet been published. The receiver, Mr. Beardsley, is now in possession.

Appointments, Etc.

MR. A. H. HARDY TROTT, late of the Thomson-Houston Electric Co. has been appointed electrical engineer of the Georgetown, Demerara, Electric Lighting Co., now about to extend its plant.

MR. HARRY W. TRUE, of Natick, will be the new manager of the Woburn, Mass. Electric Light Co.

MR. HOMER CORSE has been elected superintendent of the Groveton Electric Co., of Groveton, N. H.

MR. W. S. REED, of Kankakee, Ill., has been appointed vice-president and general manager of the Harvey Water, Electric Light & Street Railway Co.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Convince the public that you have a right to its attention, and it will always listen to you.

THE CLIMAX NOISELESS GEAR.

The accompanying illustration represents a novel form of gear wheel recently designed by the Climax Mfg. Co., of Buffalo, N. Y. It is especially adapted to mill work, electric motors, and other machinery where high duty and speed is required.

The points of excellence claimed for this gear are simplicity of construction and durability. It is made of two pieces firmly riveted together, making it impossible for the parts to work loose or for the wheel to get out of true. The teeth are machine cut, are perfect in shape and pitch, and are made in two sections, with a circumferential space between each set, and placed in such a way that each tooth of one part registers exactly with the space of the other, making the pitch practically one-half that for which

CLIMAX NOISELESS GEAR.

it is cut, and at the same time preserving the strength. This peculiar arrangement of the teeth enables the gear to engage with the pinion closely and accurately twice the usual number of teeth, thus preventing any vibration or "backlash," and, with the addition of a chamber in the web of the gear filled with non-sonorous material, the wheels when at work are practically noiseless. The space between the two sets of teeth prevents injurious contact between the teeth of the two wheels should a slight lateral displacement occur. These wheels are made of iron, and the pinions of steel, and, aside from their noiselessness, are recommended on account of their long life and durability.

C. & C. FAN OUTFITS.

The "partial list" of users of the C. & C. fan outfits has now become a fat little pamphlet of 24 pages. Even this does not disclose the full extent of the business. In New York, for example, there are nearly 250 users of these fan outfits, but many of them have ten or a dozen; and it would not be safe to say how many more have been put in during the recent hot spell. These outfits are also widely scattered all over the country, and are to be found in Japan, Canada, and other countries. The C. & C. Co. has also made a great success of its Blackman ventilating fan combination and of its blower combination for ships. The latter is now in use on board seven U. S. men-of-war.

PITTSFIELD, MASS., ELECTRIC CO.

A most interesting and valuable little brochure has been issued by the above company for the instruction and benefit of its customers, and we really must congratulate Mr. W. A. Whittlesey on so neat and masterly a piece of work. It is a model of the kind of literature that should be addressed to the actual and probable customers of a local company, and will beyond question do lots of good.

HEISLER ELECTRIC LIGHT CO.

The Heisler Electric Light Co. of Philadelphia, through their agents, the Belton Electric Co., of Belton, Tex., have just sold a complete plant at Hallettsville, Tex.

NEW YORK CITY NOTES.

THE ELECTRIC RAILWAY SPECIALTY Co. have removed their offices from 50 Broadway to the Columbia Building, 29 Broadway. This company are general agents for R. D. Nuttall & Co., and deal in railway specialties of all kinds.

MESSRS. TRUEX & VAIL, of the Electrical Exchange Building received this letter relating to the efficiency of their Swinging Ball Lightning Arrester:

ELIZABETH, N. J., June 18, 1891.

To MESSRS. TRUEX & VAIL.

Gentlemen:—In reply to your inquiry in reference to the damage done in the recent storm to our plant, would say that the account in the New York *World* newspaper of to-day is entirely wrong. The facts in the case are: We have just started an Edison power circuit in this city and had not provided it with lightning arresters, except two of the old style, which were placed in the station in the usual manner. These carried off the small inductive discharges for the early period of the storm until the very heavy and direct stroke came, when it passed the arrester and made a report like a cannon and burned out several sections of the generator armature. We had a spare armature and put the machine in operation that night. We have the Swinging Ball Arresters on our incandescent circuits, and on those circuits there was not a light out. We desire you to send us as many arresters of the Swinging Ball pattern as are necessary to thoroughly protect our power circuit, the voltage of which is 220. We may mention that we saw the Swinging Ball Arresters on the incandescent circuits, which are in the station board at work snapping off the discharges. The storm was unusually severe and struck buildings in town.

Respectfully yours,

ELIZABETH-SCHUYLER ELECTRIC CO.,

per F. H. TIDMAN, *General Manager.*

J. G. WHITE & Co. have removed their offices from 50 Broadway to the Columbia Building, where they will be glad to welcome their many friends.

MESSRS. TAYLOR & SON, of 39 Dey street, have made an improvemement in the connection of the carbon pole of their well-known primary battery. Some of the batteries which have been shipped have not worked satisfactorily owing to the carbon pole having been affected by the acid and eaten off. As this new improvement eliminates the difficulty entirely, and as Mr. Taylor desires to keep up the standard of his battery, he places this new improvement on any batteries which have been affected by the drawback cited above.

ENGINEERING EQUIPMENT CO.

WHEN it was announced last February that a number of men of good record and excellent experience in the practical affairs of the electrical equipment business were to associate themselves under the name of the Engineering Equipment Company, with headquarters in New York City, an early success and a bright future for the enterprise was predicted. This prediction has already been fulfilled in large measure, although but about four months have elapsed since the company received its first order. Among those interested in promoting the success of this company are: C. J. Field, M. E.; Albert C. Hale, Ph. D.; F. L. Perine; A. L. Tinker; F. A. Magee, M. E.; W. F. D. Crane, M. E.; C. S. Merrill, C. H. Sewall and R. B. Cone.

The company is engaged solely in the business of furnishing steam and electric equipment materials. No construction work is attempted, although facilities are at command which enable them to secure the "inside track" on figures for construction of steam power plants and electric railways. The company handles certain specialties of recognized value in the trade, and controls, in large measure or wholly, the selling of these goods in this country, in Canada, and in South America. No attempt is made to secure orders on miscellaneous steam or electrical supplies. Customers are catered to for large orders on the most important equipment materials, and, with the single exception of belting, no small orders are filled, unless as a matter of accomodation.

The Engineering Equipment Company have their chief offices in the Central Building, 143 Liberty street, New York; their stock and repair rooms at 75 Cortlandt street, New York, and their Eastern offices and salesrooms at 126 Pearl street, Boston, Mass. This company is the sole Eastern selling agency for cotton leather belting and belting specialties, manufactured only by the Underwood Mfg. Co., and for the Boston trolley and line materials, made solely by Albert & J. M. Anderson. It is also the United States and Canadian selling agency for the indurated fibre pipe, produced only at Mechanicville, New York; the Kellogg steel centre and side poles, made by the Kellogg Iron Works, of Buffalo, New York; Eastern selling agents for Habirshaw wire, cables and cores; and general agents for the machine tools manufactured by Edward Harrington Son & Co.

In addition to the foregoing lines of equipment materials, the Engineering Equipment Company deal in boilers and engines, wooden poles and cross-arms, cars, trucks, iron roofs, cranes, etc.

Those who need standard equipment materials at close figures for large quantities will do well to correspond with this enterprising and reliable company, by which large orders are being filled to the full satisfaction of customers.

MR. J. BRONILET has been appointed electrician of the Berkeley, Cal. Rapid Transit Road.

IMPROVED "STANDARD" BATTERY GAUGE.

THE Standard Electric Time Co., of New Haven, Conn., have just put their improved pocket battery gauge on the market.

This is similar in appearance to the one formerly advertised in this paper, but the mechanical parts have been changed considerably, thereby making it much stronger and less liable to damage in use or transportation.

THE TAYLOR FAN OUTFIT.

Seeing that for an initial outlay of $5 and an expense for maintenance of about half a cent an hour at the most, one can enjoy cooling breezes from an electric fan, it follows that the demand for such fans must be enormous as they become known. Taylor & Son, 39 Dey street, are making a great hit with their little fan outfit, which just answers these conditions. The motor is well built and has a 4-bladed fan, the whole thing standing 6½ inches high. Their No. 2 cell runs the motor for 12 hours on a charge which costs 6 cents, and if the solution powder is bought in larger quantities the cost is proportionally reduced.

NEW HEISLER CONTRACTS.

After a very close competition, the Heisler Electric Light Co., of Philadelphia, carried off the prize and secured the contract for an incandescent electric light plant at West Toronto Junction, Can. This company has also just sold a plant for Morrilton, Ark. They have also closed contract for an electrical installation for the Corporation of Halletsville, Texas. This contract was secured by the general agents of the Heisler Electric Light Co. for the State of Texas, M. V. Smith & Son, of Belton, Tex.

THE WORLD'S FAIR.

Mr. E. E. Keller, one of Chicago's prominent electrical engineer's and a man well known in electrical circles from his long association with the business as manager of the North American Construction Co. until the recent withdrawal from business of the company, ha saccepted an appointment from the World's Columbian Exposition as assistant electrical engineer to Prof. J. P. Barrett, Chief of the Electrical Dept., to develop and carry out the Professor's ideas and the general technical electrical work of the department. It is a position for which Mr. Keller is eminently suited, having had a wide practical and technical experience in electrical matters and especially in the arrangement, construction and erection of electrical and power machinery, and Prof. Barrett is to be heartily congratulated on his selection of so wide-awake, well-posted and energetic an assistant.

NOVELTY ELECTRIC CO.

The above company, of 50, 52 and 54 North Fourth street, Philadelphia, have published a large and very handsome catalogue of their wares and specialties. It is known as No. 15, and is 14 by 10½ inches, with 51 pages. As a frontispiece it has four fine views of the company's offices, salesroom, factory and engine room, showing a most convenient and commodious establishment. In the arrangement of the catalogue a very original method has been adopted. All the various cuts are grouped together successively, each with a simple explanatory caption. Then at the end of the book each page is taken in its turn, and very full details are given of the apparatus. In this way one gets a bird's-eye view, so to speak. of all the various apparatus in any one line, and is not bothered to keep on turning over 20 or 30 pages. After this section come several pages devoted to insulated wires, cords, cables, etc., and a variety of minor appliances. The catalogue is beautifully printed and has a stiff bronze cover and cloth back.

RAW HIDE PINIONS ON STREET CARS.

The New Process Raw Hide Co. have received the following from the Syracuse, N. Y., Consolidated Street Railway Co., under date of June 12:—" After several months' use of your pinions upon our electric cars, we are so well satisfied that we have concluded to use them on all our cars now building, and recommend them to all companies who desire to study economy, durability and comfort."

THE A. U. ALCOCK ELECTRIC LIGHT CO.

Our last Australian mail brought the third half-yearly report of the above company, of Melbourne, Victoria. It appears that the company finds a very ready appreciation of the electric light, and is preparing to build a new and very large central station at Richmond to supply Melbourne and its suburbs. Of 15,000 shares issued for the purpose, 7,000 have already been taken up by the stockholders and the remainder will be offered to the public. The Richmond station will soon be ready, and the company will sell by meter. Mr. A. U. Alcock, M. I. E. E., is the managing director and electrical engineer.

A BIG ACCUMULATOR ORDER.

Mr. Wm. Hood, the Western agent of the Accumulator Co., has recently booked one of the largest orders for storage batteries for an isolated plant ever placed. It comprises 600 15 L type, 300 ampere hour cells, which are to be used for a private lighting plant in the residence of Mr. James J. Hill, the owner of the Great Northern Railway, at St. Paul, Minn. There will be ten series of 60 cells each, giving a storage capacity for 650 16-candle power incandescent lamps for a ten-hour run. The batteries alone will require two or three freight cars to haul them to St. Paul. The landing of such a stupendous order reflects great credit on Mr. Hood, who has secured some of the largest orders for the Accumulator Company that they have ever received. Among others will be remembered the storage battery equipment for the Dubuque Street Railway Co., of Dubuque, Iowa.

NEW "WESTERN ELECTRIC" BOX BELL.

WE illustrate on this page a new box bell introduced by the Western Electric Co. It is called their "Chicago iron box bell." As will be seen, it is simple and compact. It gives a maximum power with a minimum of battery, on account of the shape and

THE "WESTERN ELECTRIC" BOX BELL.

disposition of the magnets. With one cell of battery the bell will ring over a length of 600 to 800 feet of No. 18 wire, so that for any ordinary call a single cell of battery will suffice. The hammer and armature are made from a single punching, which is copper-plated to prevent rusting. Each bell is thoroughly tested and adjusted before shipment and is guaranteed in every respect.

A BOOK FOR ADVERTISERS.

Geo. P. Rowell & Co., the well-known advertising agents, of 10 Spruce street, have just issued a "Book of Advertisers," of 368 pages, in paper cover for $1 and in cloth for $2. It contains lists of the best American newspapers and of all the trade journals, with circulation ratings, information about advertising rates, and hints as to the best means of placing newspaper advertising. Such a manual proves of the utmost value to advertisers, who always and naturally want the greatest possible return for their outlay.

THE "W. B. G." PROTECTOR FOR TELEPHONE CIRCUITS.

On this page we illustrate the "W. B. G." Protector. The inventors of this device are practical telegraph and telephone men, and understand fully the necessity nowadays of a thoroughly reliable protector for telephone and telegraph stations and instruments. Of course, any device that would be efficient in these two lines of electrical business, would be equally so in others, where apparatus is exposed to damage from heavy or abnormal currents. The protectors are mounted, 1, 2, and 3 on a base, (which is of vulcanized fibre) and in sections of 50, handsomely finished.

The single, double, and triple protectors are intended for use at telephone subscribers' stations and are mounted to accommodate "single," "metallic," and "law system," wiring. The sections of 50 are intended for use at central offices, or any place where a large number of wires enter. They are also mounted to order.

The main feature of the invention is the manner in which the fuse is melted by the generation of heat in the small coil of comparatively high resistance wire, which is wound upon one end of

The "W. B. G." Protector for Telephone Circuits.

the fuse, and which is part of the circuit. The coil is formed of German silver wire of size and length necessary to produce heat enough to melt the fuse upon the passage of any current that it may be deemed desirable to have the line "open" at. For ordinary use at subscribers' stations, they are wound to open the line at about 4-10 ampere, and for use at other places, such as central offices, where more delicate apparatus may need protection, they are wound accordingly.

The principle upon which they operate is well known and very simple, and it is evident that the device is an excellent protection against the "sneak" current, so destructive to electrical apparatus, containing electromagnets and coils of fine wire, as well as against heavy or abnormal currents.

It is also used in cable boxes, and, by a very simple arrangement, forms good protection agains lightning, as well as strong currents. These devices are already manufactured and on sale by the supply house of the E. S. Greeley & Company, of New York, who are headquarters for the goods.

The Triumph Compound Engine Co., Cincinnati, O., are doing a phenomenal business with their engines, which are giving remarkable and satisfactory results on account of their small fuel consumption and excellent service.

"THE UNITED ELECTRIC CO."

There has been a good deal of talk in the newspapers during the past week as to an electrical supply combination, and some very wild statements have been made. The rumors may, perhaps, have been due to the fact that a movement was set on foot out West about a month ago by leading men in the business for the formation of the Electrical Supply Dealers' Association, for the whole country, but the work of that body is only intended to be protective in a general way. Anyhow, the actual truth, so far as it can now be got at, is that under the name of the United Electric Co., which is now forming under the laws of Maine, the three well-known Eastern supply houses of Pettingell-Andrews Co., of Boston; Alexander, Barney & Chapin, of New York; and the Southern Electric Co., of Baltimore, have effected a consolidation, with a capital stock of $1,000,000. One or two other affiliations are spoken of, and it is said that the new concern will control the output of nine factories. Prices will not be raised, but will tend lower, owing to the economy of management, and the saving on large purchases. It is reported that the new concern will begin business under its own name August 1.

WESTERN TRADE NOTES.

Mr. F. H. Burger, the representative of the "Universal" arc lamp, 42-44 Broad street, New York, was in Chicago last week, and states that this famous arc lamp for incandescent circuits is meeting with great success in the West, and orders are rapidly coming in.

Mr. R. Humffreys-Roberts, secretary and manager of the Fontaine Crossing Co., spent a few days in Chicago last week on business in connection with the new slow-speed dynamos which are meeting with such success in ship-lighting plants. Mr. Roberts dropped in at the Western office of The Electrical Engineer.

Mr. W. F. D. Crane, M.E., the engineer of the Engineering Equipment Co., 143 Liberty street, New York, was a welcome caller at the Western office of The Electrical Engineer last week. Mr. Crane is making a short stay in Chicago looking up matters mechanical and electrical.

Mr. Clift Wise, the chief engineer of the Interior Conduit & Insulation Co., has just returned from Minneaopolis, where he conducted a very complete test of their underground feeder conduits, which showed the isulation to be perfect in every particular, the tests showing on the conduit feeders as high as 87 megohms. It will be remembered that bare conductors are used in this conduit, and the results showed the soundness of Mr. Wise's judgment in carrying out the work in this daring manner.

The Central Electric Co. are prepared to furnish the Bryant all-porcelain key and keyless sockets for Sawyer, Thomson-Houston, Brush-Swan, and Edison bases.

The Central Electric Co. report having secured more orders during the last month for special Okonite cables than ever before, and trade in general electrical supplies of all kinds is exceedingly large.

The Central Electric Co. are placing a new lead-covered cable on the market, which is known as the "Acme." It is composed of the Okonite insulation specially treated, and is designed for use under water with high voltage currents. They have recently sold one of these Okonite lead-covered cables for use in water, and have guaranteed it to withstand 5,000 volts, to which enormous pressure it will be subjected in regular service. The Central Electric Co.'s Packard lamp is rapidly coming into general favor, and they report more than 10,000 sold last month, and the new tied filament lamp of any candle power for street car use is meeting with universal approval.

Mr. George Cutter is enlarging the capacity of his shop so as to keep up with the growing demand for his pulleys and street-hoods. On his recent Eastern trip he disposed of the inventions which have been developed in his shop, and found that there is plenty of room for such specialties as he is making.

The Cicero & Proviso Electric Street Railway line is proving exceedingly popular and an immense success. It runs on West Madison street from West 48d to Harlem avenue, and returns on West Lake to West 48th and thence to Madison and back to starting point. The week-day traffic is considerable, and is steadily growing, and the Sunday line carries a very large complement of passengers. Real estate values have also been considerably enhanced by the new road.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

VOL. XII. JULY 15, 1891. No. 169.

THE FRANKFORT INTERNATIONAL ELECTRICAL EXHIBITION—I.

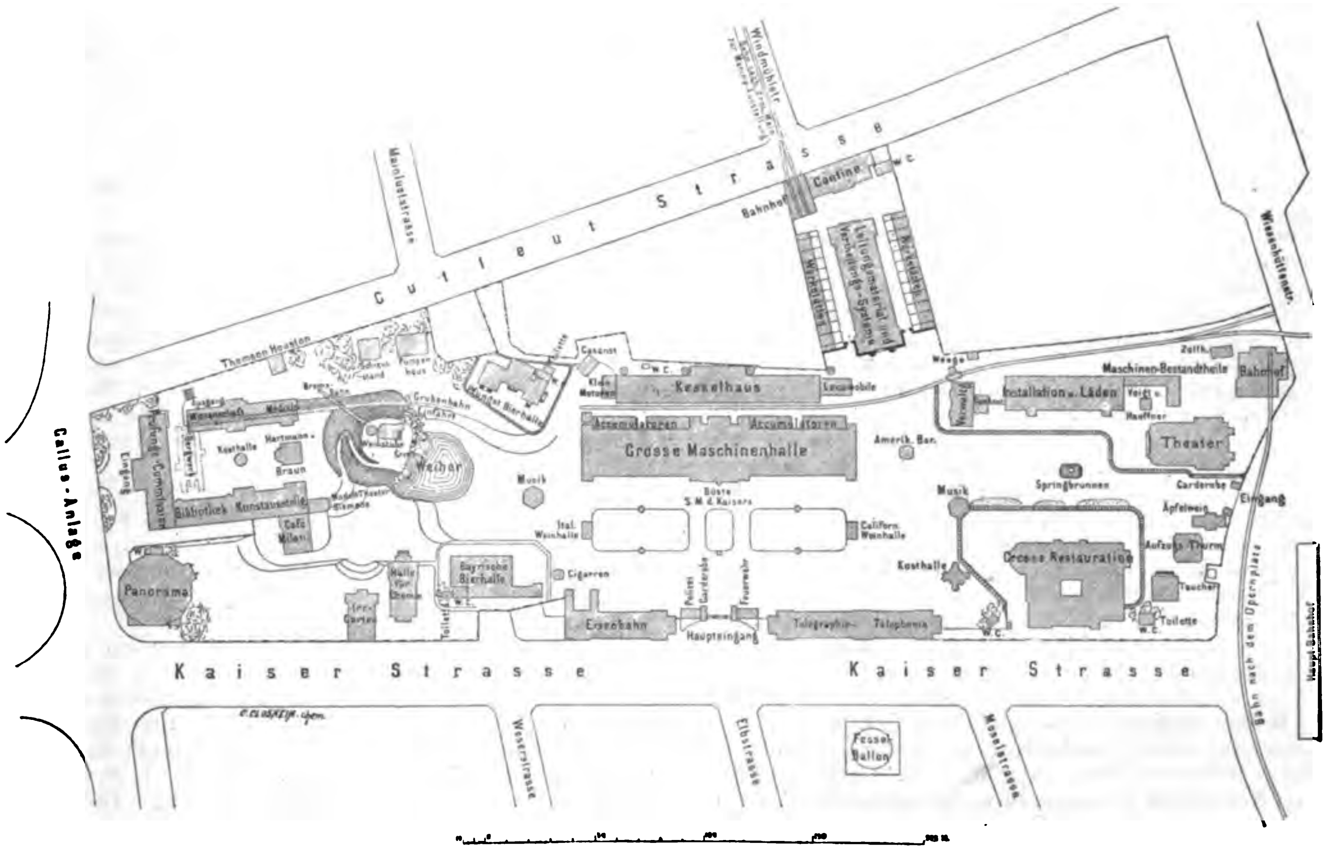
BY

Richard O. Heinrich.

NOW that nearly everything is in running order, the "Internationale Electrotechnische Ausstellung zu Frankfurt-am-Main" must be voted a great success. Most gratifying to the eye is the thoroughly artistic execution of everything on the spot, from the imposing "Machinery Hall" down to the American Bar and the drop-a-nickel-in-the-slot devices. The wiring and installation work in its extreme neatness will be a revelation to the American. The arc lamps make an excellent impression with their steady, noiseless burning.

It may be well to give intending visitors from abroad a superficial idea of what is to be seen in the exhibition. Directly opposite the main entrance is the very ornamental and imposing Machinery Hall with the boiler-house in the rear. Twenty boilers of different makes furnish steam for the engines in Machinery Hall, which aggregate about 3,000 h. p. Nearly 1,000 more are furnished by gas, petroleum and benzine motors. This boiler-house will furnish many very interesting points to the central station manager. Scarcely anything is missing of the modern devices which insure thorough economy and a complete utilization of fuel and water.

The exhibits in Machinery Hall are magnificent, and some highly interesting novelties may be seen and studied there. Between 60 and 70 engines of different makes furnish power to the dynamos exhibited. A pronounced tendency is apparent of coupling directly very large dynamos to tremendous compound engines with vertical cylinders. The majority of the engines are those intended for central station work, but quite a number of smaller gas and petroleum motors, amongst them some highly perfected types as regards regulation, illustrate the application of that class of machinery to isolated electric illumination.



PLAN OF THE FRANKFORT ELECTRICAL EXHIBITION.

One of the most interesting features and one necessitating a scrutinizing study is the "Drehstrom" motor and dynamo. Some objections have been raised against this newly coined word "Drehstrom" (rotary current), for which an English word has yet to be invented. Indeed it does not seem to cover in its signification the nature of the three-phase alternating current employed. Three different firms exhibit this new system of transmission of electrical energy for light and motor purposes. Lahmeyer

& Co., of Frankfort-on-the-Main, make a very complete exhibit of their system which also includes, besides the "Drehstrom" motors and dynamos, a system of transmission by direct current transformation by the employment of a combined motor-dynamo, that is, an electric motor which has an extra winding on the armature for the purpose of having a current generated in it for the various purposes of lighting, power transmission and charging of storage batteries. I hope to be able to give you very full information on these novelties very shortly.

The alternating current machines are, of course, fully represented, the machines of Siemens and those of "Helios," the agents for Ganz & Co., of Budapest, are the most noteworthy ones. Of long-distance power transmission we find one from the "Palmengarten," 4 kilometres distant; from Offenbach, 14 km. distant; and the one great feature to which the electrical fraternity all over the world looks with so much interest, namely, the transmission of 300 h. p. from Lauffen to the exhibition, which is to be finished, according to contract, by the middle of August.

For this transmission the Portland cement works of Lauffen furnish the turbines to utilize 300 h. p. of the Lauffen Falls. The Oerlikon works have built the necessary "Drehstrom" dynamos, which are to furnish 4,000 amperes at 50 volts. A step-up transformer will send this energy at 25,000 volts pressure from its secondary over 3 wires of 4 mm. diameter each. These wires, furnished for the purpose by Hesse & Söhne, Heddenheim, are stretched on oil insulators for a distance of 175 kilometres to the exhibition, where a step-down transformer will furnish what is left of the 300 h. p. for lighting purposes and for the running of the "Drehstrom" motors of the Allgemeine Elektricitäts-Gesellschaft.

A separate building to the southeast of Machinery Hall contains electrical appliances for central station work, overhead and underground cables and underground conduits. Felten & Guilleaume make a splendid exhibit of their famous cables. Some very beautiful metal spinning and drawing is exhibited in this building. To either side of this are workshops in which the application of the electric motor to workshop machinery is shown to advantage. This part of the exhibition, although by no means a very complete one, gives a fair idea to the non-technical public of the great flexibility, convenience and safety of the electric transmission of power. Our beloved American fan motor seems to have found no demand; there is none to be seen, but some large ventilators, driven by electric motors of course, provide the buildings with fresh air where needed.

The part of the exhibition showing the application of electric light to domestic purposes is a revelation in more than one sense. The artistic value, especially of the light fixtures, is not to be underestimated. If it has not so much direct interest for the electrical engineer, it certainly will call forth the admiration of the artist and of the manufacturer. Bronze castings and wrought-iron fixtures exquisitely delicate and of fine workmanship are the predominating materials for incandescent light fixtures. Combination gas and electric light fixtures are rarely encountered, such is the confidence of our confrères in their installation work, which is indeed remarkable even under these temporary conditions, where everything had to be done in a hurry. The sentiment on this point was very well expressed by Herr Director Lahmeyer on the occasion of the meeting of the "Gas and Water Experts," when he said that gas was good enough as long as electric light was not known, and the gas motor quite satisfactory before the time of the electric motor of to-day. I shall touch upon this meeting more fully, since some very interesting points were brought out in regard to the use of gas engines in combination with storage batteries for central station work, as practiced in Dessau and Düsseldorf.

The employment of the electric motor for traction purposes does not come up to the standard to which we are accustomed in America. Only a very small part of the electric railway as proposed is in operation at the time of this writing. It is the connecting railway between the main exhibition and the Marine Exhibition, a distance of about 1,000 feet. The motor operates smoothly, but the regulating and braking devices lack the necessary precision and the trolley seems to give occasional trouble. A later occasion will enable me to give a fuller description of the model of the single rail system of Ganz & Co. A marine railway is exhibited by Siemens and Halske, who also are to operate two cars on the street railway with storage batteries.

Some very interesting novelties are to be seen in the building for electro-metallurgy and electrolysis. Herr Fr. Goppelsroeder exhibits a process of fixing aniline colors by means of electrolysis. Electroplating is exemplified in very fine specimens, especially a process for electrobronzing palm leaves and plaster of paris castings for decorative purposes.

Quite a number of interesting and new things can also be found in the Hall for Science and Electromedicine. The exhibition of Hartmann & Braun of instruments of precision for electrical purposes is very remarkable. In this department is one of the few genuine American exhibits, that of the Weston Electrical Instrument Company, of Newark, N. J. This exhibit on account of its completeness and the remarkable properties of the well-known instruments has made quite a stir in electrical circles here. It is the intention of the Committee of Judges to use these instruments as official standard testing instruments. If America should gain a point in this new enterprise it may well be proud of it. Up to a very short time ago Germany was one of the principal exporters of testing instruments to America, but a vigorous effort of a few years only seems sufficient to turn the tide in the opposite direction.

The Maritime Exhibition is small but contains some objects of great interest, such as Schuckert's large parabolic glass mirrors, one of them having a diameter of 1,100 mm., for searchlights, while Siemens Brothers' exhibit of a torpedo station for harbor defense is very complete. The lighthouse with one of Schuckert's immense searchlights on top makes a great impression on the public. The sharply defined brilliant beams of light emanating from the searchlight proves the superiority of the patent glass mirrors made by Schuckert & Co.

It is scarcely necessary to mention that there is no lack of opportunity for the intellectual and bodily recreation of the visitor. The restaurants, cafés, kiosks, etc., speak well for the designers in their tasteful and appropriate exterior and just as well for mine host in the quality of restoratives given to the weary visitor.

The participation in the exhibition of foreign countries is fair. The United States is represented by the Thomson-Houston Co., with their dynamos and motors and with a special exhibit of electrical appliances for mining purposes. The Edison Co. is represented through the Allgemeine Elektricitäts-Gesellschaft. McIntosh, Seymour & Co. exhibit with the Thomson-Houston Co. The American Otis Elevator Co. have their electrical elevators on exhibition, and the Edison Phonograph Co., Emile Berliner's gramophone, the Westinghouse high-speed engines, and Babcock & Wilcox boilers are well represented, while American inventions can be found by the score under the names of their English and German representatives. Among the English exhibitors are Woodhouse & Rawson, the Brush Electric Co. (partly represented through Kremenezky, Mayer & Co., of Vienna,); the Swan United Electric Co., the Eastern Telegraph Co., Siemens Brothers and Johnson & Phillips, with their large coil insulators, and Ferranti with his cables. Switzerland, and especially Austria-Hungary, are very well represented. The exhibit of Ganz & Co., under the name of their agents "Helios," of Cologne, is one of the remarkable features of the exhibition and occupies the entire centre of Machinery Hall. The

German Government makes a remarkable and highly interesting exhibit, historical and otherwise. It gives a complete idea of the progress and present state of railroad signaling, automatic electric safety devices, telegraphy and telephony. A comparison with our American practice will be valuable and interesting to the visitor from abroad.

Every day, of course, brings new additions. The hall for technical drawings of central stations and isolated plants was opened a few days ago; it will furnish interesting material for a detailed description, illustrating the adopted systems of distribution of electrical energy as practiced in Germany.

As a whole it may be strongly emphasized that a visit to the exhibition will be highly profitable to the electrical engineer as well as to the non-technical public. The untiring efforts of the committee, with Herr L. Sonnemann as president, and Herr O. von Miller as vice-president, cannot be praised too highly. The visitor from the States, and especially the journalist, is always sure of a hearty welcome and of special attention and courtesy, which will enable him to study points of interest to great advantage.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—VII.

(PART SECOND.)

BY

Chas. Steinmetz.

VI. Dependence of the Electric Quantities upon Variations of the Constants of the Transformer.

In the polar diagram, we are enabled now to follow the dependence of the electric quantities in the transformer upon its constants, r_1, r, g, l, N, ρ, F, n, n_1, etc.

A. Dependence upon r_1 the Secondary Resistance.

Let, in the diagram, Fig. 12, the values, $E_0{}^1$, E^1, E_1, F_1, C^1, $C_1{}^1$, L^1, $L_1{}^1$, F, K, Λ, correspond to the transformer, when working under full load, that is, with a secondary resistance of $r_1 = 2\ \Omega$, as given before in diagram Fig. 8.

The secondary E. M. F., E_1 may be supposed to remain constant. Then the primary induced E. M. F., E_1, and thus the resulting M. M. F., F, the impressed M. M. F., K, and the M. M. F. of magnetic work, Λ also remain constant.

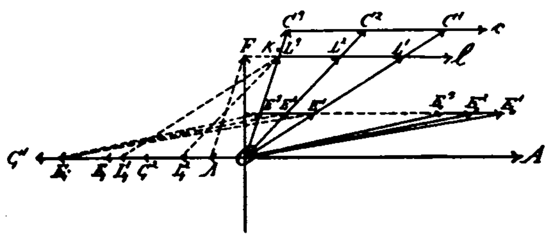


FIG. 12.

But, an increase of the secondary resistance from $r_1 = 2$ ohms, for full load, up to $r_1 = \infty$, for no load, or open circuit, produces a decrease of the secondary current, C_1 from its maximum value, $C_1{}^1$, down to zero.

Hence, with increasing secondary resistance, r_1, the point c_1, Fig. 12, moves on the ray $\overline{O\,C_1}$ from $c_1{}^1$ to O

Therefore the secondary M. M. F., L_1 proportionally decreases from $L_1{}^1$ to O, point L_1 moving from $L_1{}^1$ at full load to O, along $\overline{O\,L_1}$.

In consequence of this, ray $\overline{K\,L_1}$ shifts around the centre K from $\overline{K\,L_1{}^1}$ for full load, to $\overline{K\,O}$ for open secondary, and because of the parallelogram, O L_1 K L, ray $\overline{O\,L}$ shifts around O from $\overline{O\,L^1}$ to $\overline{O\,K} = \overline{O\,L^3}$, point L, the primary M. M. F., traveling on a horizontal line, l, from L^1 to $L^3 = K$.

Hence the primary current, C, moves along a horizontal line, c, also, from c^1 to c^3, and the resulting, or heating, primary E. M. F., E, on a horizontal line from E^1 to E^3, both E and C being proportional to L by the equations:

$$C = \frac{L}{n}, \text{and } E = \frac{C}{r} = \frac{L}{n\,r}.$$

Hence for increasing secondary resistance, that is, for decreasing load, the phase of the primary current increases

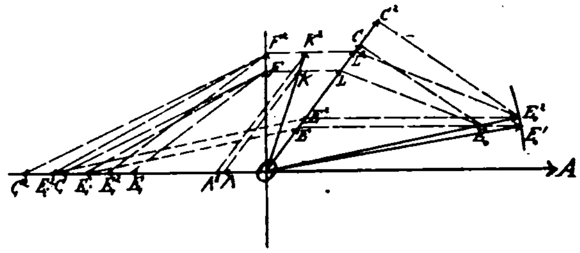


FIG. 13.

from $\varphi^1 = $ A O $c^1 = 32°$ to $\varphi^3 = $ A O $c^3 = 71°$, and the primary current decreases from:

$C^1 = \overline{O\,C^1} = 56.6$ amperes to $C^3 = \overline{O\,C^3} = 32.0$ amperes.

From this we derive the following result:

"To get a small primary current C for open secondary circuit (the so-called 'leakage current') $\overline{O\,C^3}$ must be small, that is, $\overline{O\,F}$, or rather $\overline{O\,K}$ small, with a given number of turns; that is, the magnetic resistance of the transformer must be as small as possible."

The primary impressed E. M. F., $\overline{O\,E_0}$, is derived from the parallelogram of primary E. M. F.'s, O E_1 E E_0; therefore, when for increasing secondary resistance, r_1, E travels from E^1 to E^3, E_0 travels on a horizontal line from $E_0{}^1$ to $E_0{}^3$.

"For increasing secondary resistance, r_1, if the secondary E. M. F., E_1 shall remain constant, the primary E. M. F., E_0 must decrease from $E_0{}^1 = \overline{O\,E_0{}^1} = 183$ volts, to $E_0{}^3 = \overline{O\,E_0{}^3} = 143$ volts, its phase increasing slightly from angle $\psi^1 = $ A O $E_0{}^1 = 10°$ to angle $\psi^3 = $ A O $E_0{}^3 = 13°$.

Hence the difference of phase between primary current and primary impressed E. M. F. increases with decreasing load from angle $\omega^1 = \varphi^1 - \psi^1 = 22°$ to angle $\omega^3 = \varphi^3 - \psi^3 = 58°$, and the effective power consumed by the transformer, that is, expended by the primary circuit, decreases from

$$\frac{C^1\,E_0{}^1 \cos\omega^1}{2} = 4840 \text{ watts to } \frac{C^3\,E_0{}^3 \cos\omega^3}{2} = 1830 \text{ watts.}$$

In actual practice, certainly for open circuit, all the quantities are esssentially smaller than assumed here, as remarked before.

Fig. 12 gives the diagrams for the secondary resistances:

1. $r_1{}^1 = 2$ ohms: full load.
2. $r_1{}^2 = 4$ " : half load.
3. $r_1{}^3 = \infty$: no load.

Therefore, if for increasing secondary resistance, that is, decreasing load, the secondary E. M. F. shall remain constant, the dynamo has to be regulated so that the impressed primary E. M. F. decreases from $\overline{O\,E_0{}^1}$ to $\overline{O\,E_0{}^3}$.

On the other hand, if the primary E. M. F. E_0 is kept constant, as usually, the secondary E. M. F., E_1, will not remain constant, but will increase for increasing resistance r_1, that is, for decreasing load.

The amount of this decrease we get in the following way:

After having produced, in Fig. 13, the transformer diagram for full load, and for any other load, for instance half load, under the assumption of constancy of secondary E. M. F., E_1, we increase, in this latter diagram, all the lines proportionally, so that the primary impressed E. M. F., E_0, has again the same value as for full load.

Graphically we do this by drawing parallel lines.

Let, for instance, in Fig. 13, E_0^1, E^1, E_1, E_1, C^1, C_1^1, L^1, L_1^1, F, K, $\varDelta$ be the diagram for full load, E_0, E, E_1, E_1, C, C_1, L, L_1, F, K, $\varDelta$, the diagram for half load, or any other load.

Then we draw a circle with radius $\overline{O E_0^1}$ and produce $\overline{O E_0}$ until it intersects this circle in E_0^2, produce $\overline{E_0^2 E^2} \parallel \overline{E_0 E}$, $\overline{E_0^2 L^2} \parallel \overline{E_0 L}$, $\overline{F^2 L^2} \parallel \overline{F L}$, $\overline{E_1^2 F^2} \parallel \overline{E_1 F}$, $\overline{E_1^2 F^2} \parallel \overline{E_1 F}$, $\overline{C_1^2 F^2} \parallel \overline{C_1 F}$, etc.

then E_0^2, E^2, E_1^2, E_1^2, C^2, C_1^2, L^2, L_1^2, F^2, K^2, $\varDelta^2$ is the transformer diagram for half load, and the same impressed E. M. F., E_0.

CENTRAL STATION MANAGEMENT AND FINANCE.—XI.

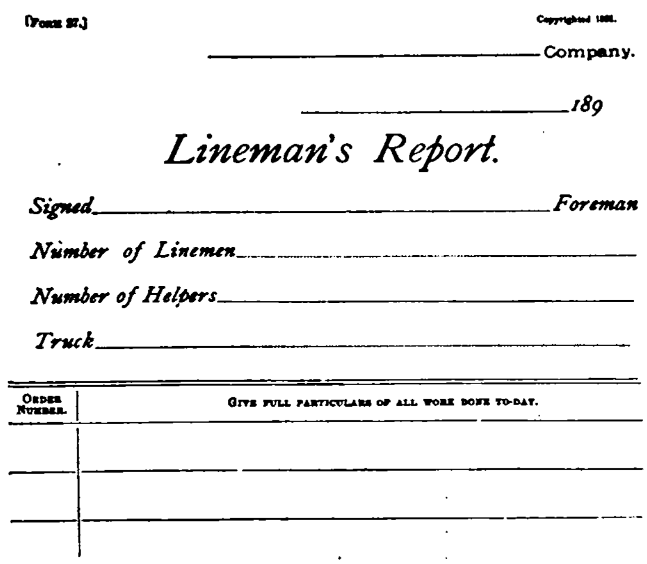
BY

Horatio A. Foster

Miscellaneous Forms.

The foregoing finish up the blanks used in the department of accounts and leave us only one more of the regular order. That form is No. 27, Lineman's Report, on which is recorded all work of any nature done by line gangs. It must be filled out in detail by all foremen or any man who has a job all alone; this blank will be all that is necessary outside of the regular order blank No. 1.

When electrical apparatus or wires are placed inside of buildings it is necessary to notify the Board of Fire Underwriters immediately of such fact, so that the customer's

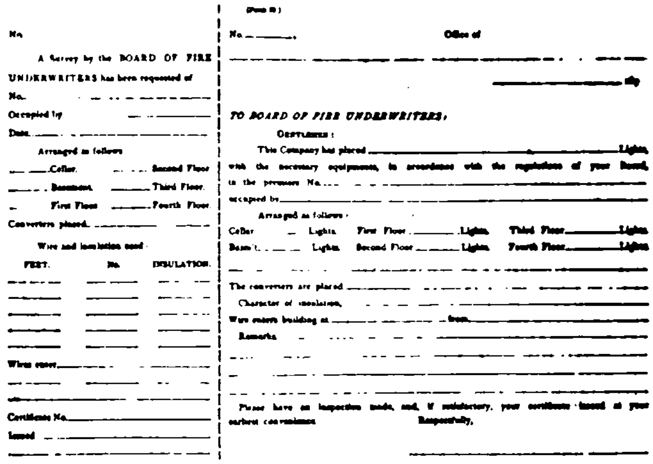


BLANK NO. 27.—LINEMAN'S REPORT.

insurance may not be made invalid. For such notification the form issued or suggested by the New York Board has been found very convenient, and when a stub is added and it is made into books of about 200 pages leaves little to be desired. No. 29 shows this form. I use it here with the kind permission of the Board of Fire Underwriters, through Mr. A. E. Van Gieson.

This furnishes the line of regular reports, and it is hoped that they have been found to cover the ground more or less fully. Many stations will require special blanks, and I shall be glad to render assistance on application, with proper blanks gotten out to meet the service.

In closing, I will say that the foregoing system of blanks, while not being advanced as absolutely perfect, has been well tried and found to answer the writer's purpose in his own central station work with considerable satisfaction. It is hoped others may find some assistance in



BLANK NO. 29.—APPLICATION FOR FIRE UNDERWRITER'S SURVEY.

them, and that they may lead to a more intelligent knowledge of the costs of maintaining and operating electric lighting and power stations.

SCIENTIFIC NOTE MAKING.

BY

J. Stanford Brown.

MOST of us, especially in the great field of electricity, have to keep abreast of the times by diligent perusal of periodical literature in one or several languages, and everything that can assist the task of memory is a blessing of no small import.

The student must, weekly at least, glance through such a pile of papers that he shrinks from the task. No one can hope to retain much or accurately from a single reading, and consequently the only safe way is to put down the titles of articles and the facts to which it may be necessary to refer for further study or direct application in the engineering problem in hand.

Note books belong to the methods of the past, for at the end of a few months all available time would be consumed in making indices to the indices of the volumes filled.

Our resource, then, must be a scientific system such as that offered by the Library Bureau, so admirably worked out first for use in cataloguing collections of books.

The plan is simple. Cards of two sizes are provided. When the titles only of books or articles are required, a narrow card is used, while more extensive notes are made on those of ordinary postal size (3″ x 5″). If both kinds of memorandums are to be made, it is best to use only the larger size.

These cards are filed in tin boxes, or in wood cases of any desired dimensions and finish, holding from 3,000 to 50,000 cards. For many reasons, a number of boxes of some medium size will be found preferable in case of change of residence, or when a part of the cards are taken to one's office, or on a journey, when spare time is put in studying or writing up. The cards stand on edge and can be consulted in situ or removed, as preferred. As soon as subject-matter is out of date, or of no further value, for any reason, out it goes, without defacing anything, and leaving room for new facts and figures.

One great advantage in this system of records is that for any particular work the whole collection can be rearranged at any time, on any new classification seeming to offer peculiar advantage.

The classification of notes forms in itself an interesting study. The top line of each note card should be left for the title and subdivision heading. The arrangement of cards in the cabinet can be made to suit individual fancy by subject groups and alphabetically within each group, or all under one general alphabet with subdivisions. Zinc didivisions, with the tops turned over for labels, and cards with projecting tops, of various shapes, can be had, as well as alphabets in cardboard of several colors.

The headings to cards are the most difficult stumbling-block for the beginners. It is wise for them even to omit these for the first few months, until by practice and thought a system of classification has been elaborated to suit individual ideas or necessity. In any event, titles should be put down according to the rules universally adopted for cataloguing, which rules should be strictly adhered to.

It would be of immense help if all writers of articles and the editors of our technical journals would unite to make titles as simple as possible. Were this thought kept in view, then, in taking notes or cataloguing, few or but small changes would be needed. Too many titles to articles fail to strike the keynote. For instance, in the current electrical journals we find "A German Current Transformer." Those interested want to know who designed it, and if it had been termed "Lahmeyer Continuous Current Converter, Type '91," no one would have had to go further, unless in search of detailed information.

Do not forget to put down the source of the memorandum. Without this it frequently loses half, if not all, its value. The information may be used, and some one may challenge its accuracy; a slip may have been made in copying it; not quite enough may have been taken for clearness, or track of the context have been lost, when occasion requires further reference to it.

Not infrequently it is very important to put down the author of the article when a simple fact or statement is extracted. Such memoranda may be useful either for the purpose of knowing the views of some authority or his peculiar use of terms where the same technical term is used by different men in various senses.

How often one runs across the title "A New Dynamo" which is new for that copy of the paper only in which the account is given. Take the file of almost any electrical journal, and such entries will be found half a dozen times in a single volume. A little different wording, and we could pass along without delving into the text.

"On a possible method of making physical measurements with the aid of a modified form of——————'s galvanometer," might better have been "Blank's Tangent Galvanometer." The last was from our German friend, and yet some of the titles to articles read before the English learned societies require considerable study to decide under which of several heads they properly fall.

To make the title describe the article concisely and briefly is not always an easy matter, but a little thought will improve matters wonderfully, and let us give thanks to our editors who appreciate these points.

Double entries are many times necessary, but take time —too much time—to be used freely.

Abbreviations for works recurring regularly will, of course, facilitate note making, and the advantages of uniformity are self-evident. Impressed with its importance, in Nov., '84, Mr. Haspitalier brought the subject before the International Society of Electricians at Paris, who appointed a committee to investigate and report on a standard list of terms and abbreviations. For full details see *L'Electricien*, 15 D., '84.

On 14th May, '85, Andrew Jamieson read a paper before the S. of T. E. and E. on "Electrical Definitions, Nomenclature and Notation," which gives very fully suggestive abbreviations, as well as the many meanings of the same terms as used at that date. Those desiring to look up this matter will find it in E. E., IV., 338 (No. 45, Sept. '85), or in E. W., V., 18, or L. E., XV., 30. Useful letters bearing on the correct use of terms may also be found in L. E., XV., 60, and 311.

In the matter of the names of electrical journals the writer is accustomed to use, among others, the following initials:

E. E.	For the N. Y. *Electrical Engineer;*
E. R.	" " " " *Review;*
E. A.	" " " " *Age;*
E. W.	" " N. Y. *Electrical World;*
E. P.	" " *Electric Power;*
W. E.	" " *Western Electrician;*
E. R.	" " London *Electrical Review;*
L. E.	" " " *Electrician;*
E. E.	" " " *Electrical Engineer.*

&c., using square letters for the English, and round caps for the American periodicals. Probably no shorter ones will suggest themselves.

Some might think it wise to use stenography. The chief objection to this is the one common to all short hand work. Before long too much of it will probably be "Greek" even to the writer, and so be consigned to the waste basket; the notes are meaningless to any one else who might profit by them, and you cannot ask your brother or sister or office boy or any one to find a reference for you while you are busy at something else.

To the scientist and engineer the taking of notes must be an art, and one of sufficient importance some think to warrant consideration in our schools and colleges. No doubt in our most advanced institutions this matter does receive the deserved attention. If not, and these suggestions serve to call the matter before professor or student, to the benefit of either, they will have accomplished a useful purpose.

THOMSON'S INDUCTION PREVENTER FOR TELEPHONE CIRCUITS.

In the operation of telephone lines much annoyance has been caused by the induction from neighboring electric light or railway wires. This defect may be overcome, it is true, by the use of metallic circuits, but the great cost of this remedy has proved a drawback to its general use, and the all-metallic circuit has in this country been principally confined to long-distance telephony.

In order to prevent these injurious inductive effects on single circuits with earth return, Prof. Elihu Thomson has recently devised an arrangement, the object of which is to obtain a compensation for the induction from one line to several others in a simple and effective manner, without, in so doing, causing one of the affected lines to induce currents upon another affected line or lines. Thus, in the case of two telephone-circuits affected by an electric light wire, the induction of the electric-light wire upon both telephone wires is eliminated without causing induction from one telephone wire to another.

This result is accomplished by setting up a counteracting field of induction, which operates upon both telephone circuits, each of which is arranged in a different portion of the field of counter-induction, but in position not to induce upon the other.

The method will be understood by reference to the diagram. Fig. 1 represents diagrammatically an ordinary telephone line, which lies parallel to a line L L L either along a part or the whole of its course. The line in the electric-lighting circuit is one in which fluctuations or alternations occur in the current supplied from a generator D. Looped into the electric-light line at any convenient point is the coil P of a comparatively small number of turns, according to the strength of the current and the induction which it is expected to balance. Placed near it, either parallel to it, or at an angle with its axis, is a coil S, generally of much finer wire, and including with it the telephone-circuit T as a loop. By adjusting the relative angular positions of the coils S and P with respect to each other while listening at a telephone in the telephone line, a counter-induction may be set up equal to that which is

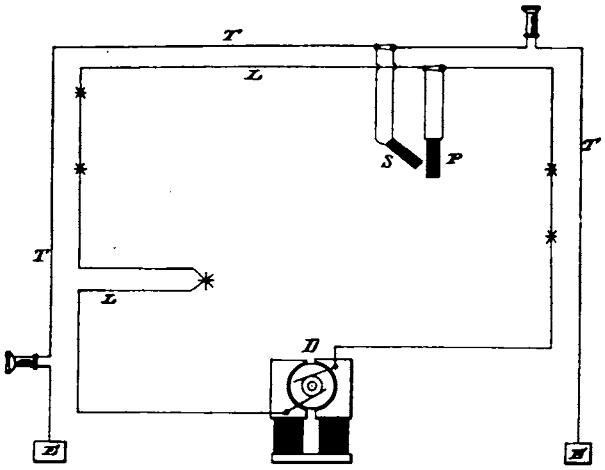


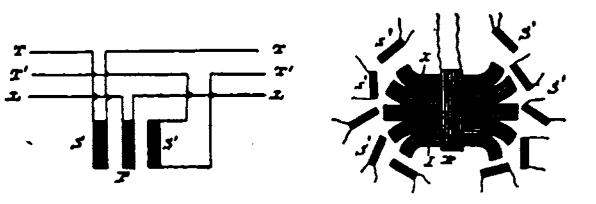
FIG. 1.—THOMSON'S METHOD OF PREVENTING INDUCTION IN TELEPHONE LINES.

produced on the main line, thus producing silence in the telephonic circuit.

This compensating effect may, of course, be produced in a variety of ways. It is necessary, of course, that the connections be so made that an impulse inductively set up shall be met by a reverse or opposite impulse also inductively set up. One of these impulses, however, is that which is due to the long lines in parallelism on poles or in conduits, and the other is that due to the adjustment of the inducing-coils one to the other.

The arrangement preferred by Prof. Thomson is shown in Fig. 2, where T T and T′ T′ indicate two lines parallel with, or adjacent to, the electric-light line L L, with alternating or fluctuating currents flowing in it. The coil P in the electric-light line has on one side of it adjustably placed a coil S in the circuit of the line T T, and in the other side a similar coil S′ in the circuit of line T′, so that the coil P may act inductively on both circuits T T and T′ T′. The coils S S′ are kept sufficiently far apart not to allow cross-talk by induction from one of the telephone coils to the other.

Fig. 3 illustrates a modified way of permitting a single coil P of moderate size in an electric-light line to affect in-



FIGS. 2 AND 3.—THOMSON'S METHOD OF PREVENTING INDUCTION IN TELEPHONE LINES.

ductively a number of coils variably placed as to the power of induction, and each inserted in a particular telephone circuit, without permitting the approach of the small telephonic-circuit coils to allow cross-induction, or cross-talk. The small coils are adjusted both as to the position and angle, &c., and arranged around the coil P, which may be without a core of any kind, or which may have a core I, of iron wire bundles, threaded through it and run in different directions, as indicated, to separately-influenced coils S′, &c., which are connected in individual telephone-circuits.

TESLA'S METHOD OF OPERATING ALTERNATING CURRENT MOTORS WITH CONDENSERS.

If the terminals or plates of a condenser be connected with two points of a circuit, the potentials of which are made to rise and fall in rapid succession, the condenser allows the passage, or, more strictly speaking, the transference of a current, although its plates or armatures may be so carefully insulated as to prevent almost completely the passage of a current of unvarying strength or direction and of moderate electromotive force; again, if a circuit, the terminals of which are connected with the plates of the condenser, possess a certain self-induction, the condenser will overcome or counteract to a greater or less degree, dependent upon well-understood conditions, the effects of such self-induction; third, if two points of a closed or complete circuit through which a rapidly rising and falling current flows, be shunted or bridged by a condenser, a variation in the strength of the currents in the branches, and also a difference of phase of the currents therein, is produced.

These effects Mr. Tesla has utilized and applied in a variety of ways in the construction and operation of his well-known alternating motors, as, by producing a difference in phase in the two energizing circuits of an alternating-current motor by connecting the two circuits in derivation, and connecting up a condenser in series in one of the circuits.

In an alternating-current motor of the type which has an armature coil or circuit closed upon itself, however, the latter represents not only an inductive resistance, but one which is periodically varying in value, both of which facts

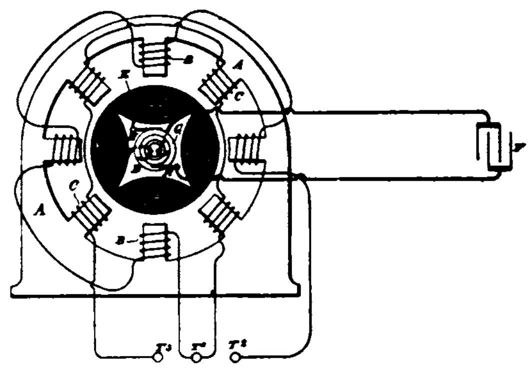
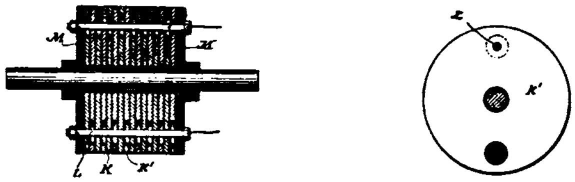


FIG. 1.—TESLA'S NEW ALTERNATING MOTOR WITH CONDENSER.

complicate, and render difficult, the attainment of the conditions best suited to the most efficient working of the motors. The most efficient working conditions, in other words, require, first, that for a given inductive effect upon the armature there should be the greatest possible current through the armature or induced coils, and, second, that there should always exist between the currents in the energizing and the induced circuits a given relation of phase. Hence whatever tends to decrease the self-induction and increase the current in the induced circuits will, other things being equal, increase the output and efficiency of the motor, and the same will be true of causes that operate to maintain the mutual attractive effect between the field-magnets and armature at its maximum. He secures these results by connecting with the induced circuit a condenser, and also by constructing the motor in a special manner.

The general plan of operation adopted by Mr. Tesla is illustrated in Fig. 1. A A in this figure represent the frame and field-magnets of an alternating-current motor, the poles or projections of which are wound with coils B and C, so that the alternating currents flowing through the circuits, respectively, will have a difference of phase. Within the influence of this field is an armature-core D, wound with coils E. In Mr. Tesla's motors of this description, heretofore these coils have been closed upon themselves, or connected in a closed series; but in the present case each coil or the connected series of coils terminates in the opposite plates of a condenser F. For this purpose the ends of the series of coils are brought out through the shaft to collecting-rings G, which are connected to the condenser by contact brushes H, the condenser being independent of the machine. The armature-coils are wound or connected in such a manner that adjacent coils produce opposite poles.

The action of this motor and the effect of the plan followed in its construction are as follows: The motor being started in operation and the coils of the field-magnets being



FIGS. 3 AND 4.—COMBINED ARMATURE AND CONDENSER.

traversed by alternating currents, currents are induced in the armature coils by one set of field coils, as B, and the poles thus established are acted upon by the other set, C. The armature coils, however, have necessarily a high self-induction, which opposes the flow of the currents thus set up. The condenser F not only permits the passage or transferrence of these currents, but also counteracts the effects of self-induction, and by a proper adjustment of the capacity of the condenser, the self-induction of the coils, and the periods of the currents, the condenser may be made to overcome entirely the effect of the self-induction.

It is preferable on account of the undesirability of using sliding contacts of all kinds to combine the condenser with the armature directly, or make it a part of the armature. In some cases, as shown in Fig. 2, Mr. Tesla builds up the armature of annular plates K K, held by bolts L between heads M, which are secured to the driving shaft, and in the hollow space thus formed is placed a condenser F, generally by winding the two insulated plates spirally around the shaft. In other cases he utilizes the plates of the core itself as the plates of the condenser, as shown in Figs. 3 and 4.

In motors in which the armature coils are closed upon themselves—as, for example, in any form of alternating-current motor in which one armature coil or set of coils is in the position of maximum induction with respect to the field coils or poles, while the other is in the position of

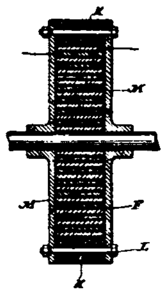


FIG. 2.

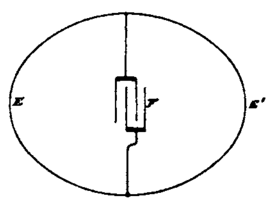


FIG. 5.

minimum induction—the coils are connected in one series, and two points of the circuit thus formed are bridged by a condenser. This is illustrated in Fig. 5, in which E represents one set of armature coils and E′ the other. Their points of union are joined through a condenser F. It will be observed that in this disposition the self-induction of the two branches E and E′ varies with their position relatively to the field-magnet, and that each branch is alternately the predominating source of the induced current. Hence the effect of the condenser F is twofold. First, it increases the current in each of the branches alternately, and, secondly, it alters the phase of the currents in the branches, this being the well-known effect which results from such a disposition of a condenser with a circuit, as above described. This effect is favorable to the proper working of the motor, because it increases the flow of current in the armature circuits due to a given inductive effect, and also because it brings more nearly into coincidence the maximum magnetic effects of the coacting field and armature poles. This method of operation is more particularly adapted to systems in which a very high rate of alternation or change is maintained.

THE DIELECTRIC PROPERTIES OF MICA AT HIGH TEMPERATURES.

IN a paper recently read before the Académie des Sciences, M. E. Bouty described some investigations carried out by him with regard to the dielectric properties of mica at high temperatures. The result of M. Bouty's researches is to demonstrate the almost complete invariability of the dielectric constant of mica, which, between 0° and 300°C., certainly does not alter by one-fiftieth of its original value. Above 300°C. experimental complications occur, and tend to obscure the result. M. Bouty made use of silvered sheets of mica, and when the temperature was carried beyond 300°C., the silver was attacked if in contact with the air, and the mica was soon covered by a transparent electrolytic film. This defect may be minimized by covering the silver with a fairly thick layer of copper. Above 300°C. the charge furnished by the battery is no longer entirely recoverable, which is doubtless due to the formation of the conducting film, since the conductivity at the same temperature rapidly increases if the application of the heat is prolonged, and the conductivity is maintained on cooling until the superficial hygrometric layer has been washed away in alcohol. It is possible that between 300° and 400°C. mica may possess some slight specific conductivity. However that may be, says M. Bouty, the resultant conductivity between 300° and 400°C. is negligible for charges of brief duration.

A SENSITIVE ELECTRICAL ALARM.

AT the last meeting of the Académie des Sciences, MM. G. and L. Richard described an electrical alarm devised by them for the purpose of responding to variations in the pressure of a current of air or gas. The alarm is extremely sensitive, and will act for variations of a few hundredths of a millimetre of water. The apparatus consists of a metallic box communicating with the flue, through which the gas is flowing, by a small tube. This tube is closed inside the box by a light metal valve, the movements of which open and close an electric alarm circuit. By altering the position of the box with regard to the vertical, the sensitiveness of the apparatus is more or less modified, and beyond a certain point the apparatus may be made to indicate an increase of pressure. MM. Richard propose to fix this device to ventilating tubes or to flues. In some cases it may be necessary to have an additional automatic device to prevent purely momentary depressions from affecting the instrument. Where required the alarm circuit could be made to include an electro-magnet which should attract a bar of soft iron actuating a train of clock wheels, which, when a certain definite time had elapsed, should allow the alarm to ring.

MAGNETIZATION OF NICKEL.

ONE of the most interesting of the exhibits at the recent Royal Society *conversazione* was Mr. Shelford Bidwell's nickel pendulum, arranged to show that nickel, which at ordinary temperatures is magnetizable, loses its power of being magnetized when heated to 300 deg. C.

THE NEW CROCKER-WHEELER ARC MOTORS.

The problem of designing a successful automatic speed regulator for constant current or arc motors has been grappled with as often as almost any problem in electrical engineering. A method which has been frequently tried consists in shifting the brushes in correspondence with variations in the load on the motor. This attempt has never been sufficiently successful to warrant the commercial use of the method, owing to excessive sparking at the brushes, and bad design and construction of the device.

In the new constant current motor of the Crocker-Wheeler Co., designed by Dr. S. S. Wheeler, this method of regulating by shifting the brushes has been very successfully accomplished, and the difficulties of sparking and faulty mechanical operation have been entirely overcome. The details of the construction of the regulator are shown in the engravings, Figs. 1, 2 and 3. The means for adjusting the governor are very complete, the tension of the spring being regulated by a nut on the shaft at E, so that the governor can be set to run at any desired speed. The stroke of the governor is also limited by two set-screws controling the extent of the motion of the bell-crank lever connecting the centrifugal governor and the rocker-arm carrying the brushes. A dash-pot is also connected with this lever to prevent too sudden action of the governor. The rocker-arm is carried on the end of the bearing by three friction rollers, shown at *c* in Fig. 3. These contribute greatly to the prompt and easy action of the governor. The workmanship of the whole device is of the most perfect character, and its operation is correspondingly effective. The centrifugal governor on the end of the shaft is surrounded by a guard ring as indicated in Fig. 4, which shows the complete motor in perspective.

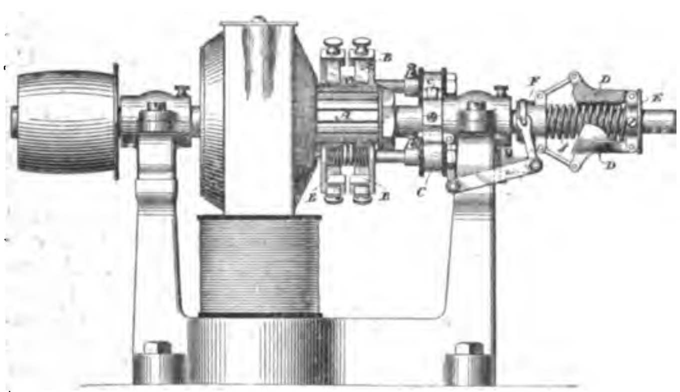


Fig. 1.—New Crocker-Wheeler Automatic Constant Current Motor.

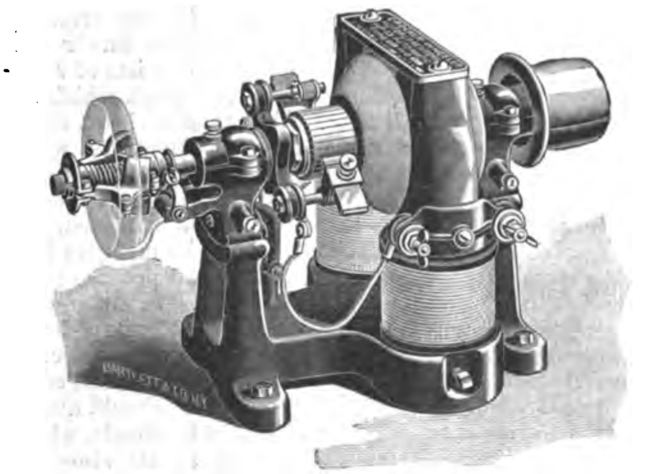
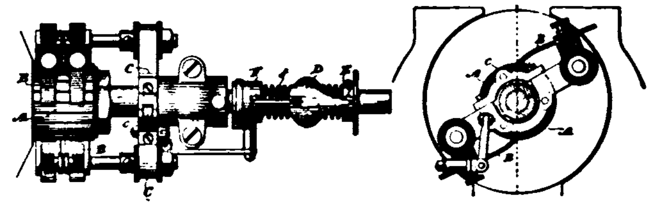


Fig. 4.—Crocker-Wheeler Automatic Arc Motor.

It is obvious that this method of regulation is prompt, because the instant the position of the brushes is shifted, the torque of the motor is correspondingly reduced, and even when the belt is thrown off with full load, the action of the governor, and its effect in controling the speed of the motor is practically instantaneous.



Figs. 2 and 3.—Crocker-Wheeler Arc Regulator.

The automatic form of regulator is employed on all the larger sizes of motors, but the sizes which are too small to make it practicable to apply the centrifugal governor and connecting mechanism are provided with a hand regulator. This form is shown in Fig. 5. The rocker-arm shifts the brushes from the position of maximum effect to minimum effect in proportion to the load, as in the larger motors, the motion being effected by a lever and string, which may be worked by hand or treadle. When the lever is released the brushes are thrown back to the position of least effect by the spring shown in the engraving.

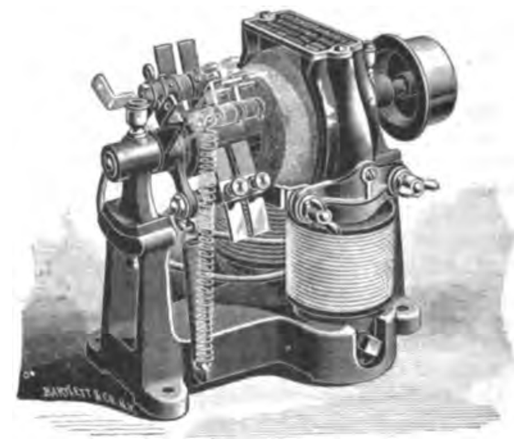


Fig. 5.—Small Crocker-Wheeler Arc Motor.

A DEFINITION OF "DEVELOPMENT" WANTED.

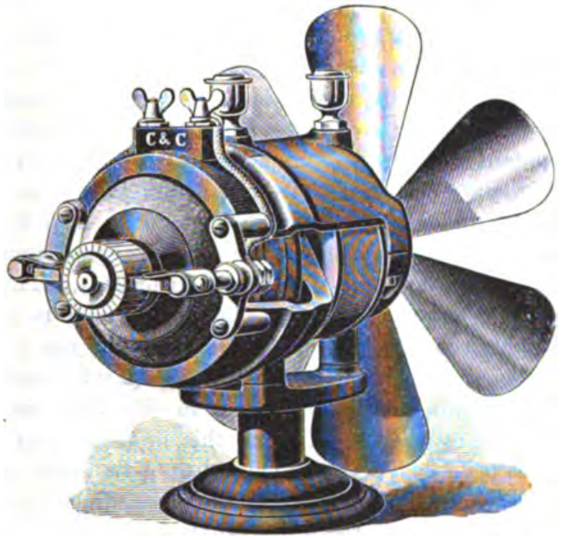
Referring to the serious fire last week in this city in the Sixth Avenue horse car stables, and commenting on the fact that the road still sticks to horses, the New York *Times* says:—"The delay may very probably be due to the fact that the managers of the lines are waiting for the development of electric traction, *which cannot as yet be said to have been developed*, and object in the meantime to going to the expense of a plant for a system of cables which may, after all, be provisional." The italics are ours, for we would like to be informed as to what is understood by the word "developed." There are now over 325 electric roads in the world, and 90 per cent. of them in this country. Those roads figure up about 4,000 cars, 7,000 motors, 2,600 miles of track, a daily run of 400,000 miles and a traffic of 750,000,000 passengers yearly, and not a single death attributable to contact with the circuit or the electric apparatus. If this be not development, and of a very high form, too, we would very much like to know what is.

THE "C. & C." 500-VOLT FAN OUTFIT.

The great increase in street railway and other power circuits of a pressure of 500 volts has recently led to a demand for small motors and fan outfits adapted to this voltage.

The problem of designing a 1/6 or 1/4 h. p. motor for so high a voltage has many factors that do not occur in building larger machines, while some of the main objects to be attained in large machines assume a very different aspect in these pygmies. For example, in the matter of economy of copper these small motors cannot be laid out for the least weight as larger ones, owing to the great increase in cost of the smaller sizes of wire, so that the least cost may be far from the least weight.

Again, one is limited by the mechanical strength of the wire, as the finer sizes are apt to be drawn out or broken in the rapid handling necessary in manufacturing on a large scale.



"C. & C." 500-Volt Fan Outfit.

Another difficulty in designing is the limitation in size, especially in fan outfits which must be small enough to move from place to place, while at the same time the area of the pole pieces must be large enough to reduce the armature turns to a reasonable number. Finally the cost of construction must be reduced to a minimum, as the wire alone on a high-volt machine may cost as much as a whole motor of low voltage.

With these points in view the motor herewith illustrated has been designed by Mr. F. V. Henshaw, of the "C. & C." Electric Motor Co.

The field magnet is semi-ironclad, being formed of two castings joined at one end and held by a single bolt, while the opposite projecting ends form the poles. The lower casting has a cylindrical core over which the single field coil is slipped. This core is cast hollow and the shaft passes through it, having bearings at each end. As will be seen, this arrangement allows a relatively large diameter of armature without increasing the size of the machine greatly. The armature is of the ring type supported on the shaft by three arms. The whole front of the armature is covered by a rubber disc against which the commutator is fastened. This disc serves to keep the frail connecting wires in place and also as a protection to the armature. The brush-holders carry two or more round carbons of standard size, which can be replaced by simply turning the holder around, putting in new pieces and turning back. Both field and armature coils are wound separately on a lathe. With duplicate sets of armatures and field bobbins of the proper winding it is but the work of a few minutes to change these machines from one voltage to another, which is sometimes convenient.

The 1/6 h. p. motors are finished with bearings requiring very little oil, while the larger motors have self-oiling bearings.

The "C. & C." Electric Motor Co. are turning out large numbers of those machines, the demand for which is constantly increasing.

APPRECIATION OF "THE ELECTRICAL ENGINEER."

A letter received last week from a reader of The Electrical Engineer in Southbridge, Mass., says: "I am a subscriber to your paper; have been for some time; like it better than any other. May your shadow never grow less." Another kind reader in Kewannee, Ill., writes: "I do not want to miss one number if I can help it. I have read several electrical papers, but the The Electrical Engineer is *the* paper for anyone who wants to learn the news in that line. I would not give it for two of the other papers."

THE IMPROVED WURTS-WINSOR LIGHTNING ARRESTER.

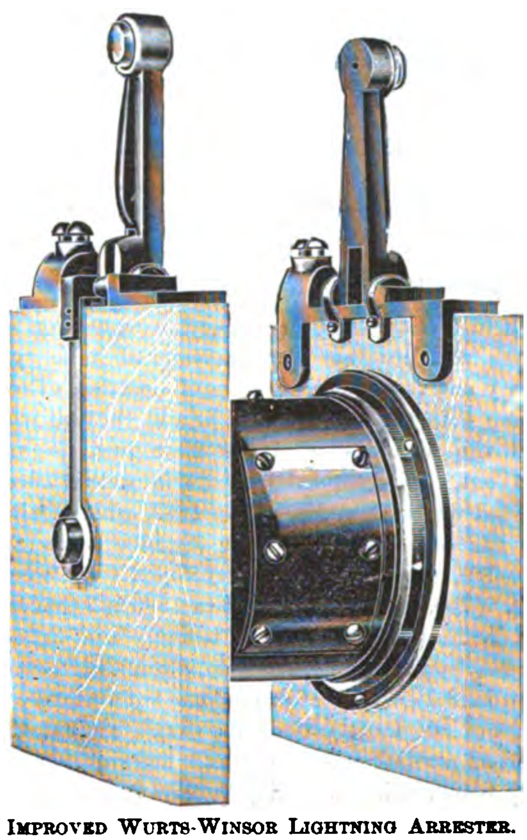
Since the Wurts-Winsor lightning arrester was brought out by the Westinghouse Electric & Manufacturing Company the demand for these appliances has greatly increased, and to-day lightning arresters are considered to be an essential feature in all electric light and power stations.

Mr. Wurts has lately made many improvements in the construction of this apparatus, and while it was unnecessary to modify the principle embodied in the very first one, the changes made add much to its simplicity.

The accompanying illustration represents the new style of the arrester for incandescent circuits. Its distinctive features are that it is constructed of incombustible material, it operates without any electromagnetic device, and its arc is self-destructive.

The engraving represents the lightning arrester in its normal position ready for a discharge. The apparatus is compact and consists of very few parts. It has a cylindrical air chamber of brass, each end of which is covered with a marble plate. Two discharge points on opposite sides of the air chamber, consisting of brass tubes tipped with carbon, are attached to brass lever arms in such a manner as to swing freely through circular openings in the marble plates. Within the air chamber is a carbon ball held stationary in the centre, and the two discharge points approach this ball to within one-sixteenth of an inch. The carbon ball is grounded and the lever arms connected to the respective poles of the generator.

The operation of a discharge is as simple as it is effective. Supposing a lightning discharge to come in from the line, the discharge will take place from two discharge points to the carbon ball and from thence to the ground, forming a double arc in the air chamber. The dynamo current will then follow, causing a short circuit on the generator, and the heat produced by these arcs will expand the air in the chamber and drive the two discharge points out, thus extinguishing the arcs and rupturing the short



Improved Wurts-Winsor Lightning Arrester.

circuit. The next moment the discharge points swing back to their former position within the chamber, and the apparatus is at once ready for another discharge. The entire apparatus is automatic, and when the lightning arrester is once placed in position it requires no further attention.

In testing one of these arresters the binding posts were connected to the poles of a 1000 volt 1,500 light alternator, and the two air-spaces were bridged over with a small strip of tin foil. Then by the throw of a switch the generator was short-circuited through the arrester, the tin foil was fused, the air expanded, the discharge points were forced out of the air chamber against the bumpers, the arcs were blown out with a report like a pistol shot, and the discharge points returned to their normal positions ready for a fresh discharge; all in an inconceivably short space of time,

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers*

VOL. XII. NEW YORK, JULY 15, 1891. No. 167.

The first requisite of an observer is that his mind should be actively awakened to the phenomena of nature with which he is surrounded.—Joseph Henry.

THE FRANKFORT ELECTRICAL EXHIBITION.

ONE of the most significant facts in connection with the rise and progress of the electrical industry is the popularity and frequent recurrence of electrical exhibitions. Beginning with the one held in Paris in 1881, at which the arc and the incandescent lamp were first prominently brought out, there followed others in annual succession. The second was that at Munich in 1882, where Deprez first showed the possibilities of long-distance electric power transmission, which have now developed into tremendous realities. The Vienna exhibition in 1883 and that at Philadelphia in 1884 served only to increase the demand for such shows, so that no general exhibition since that period has been held in which electricity has not formed a prominent, if not the most prominent, part. That the interest in electrical matters is not only not flagging, but on the contrary is increasing from day to day, is evidenced by the exhibition just opened in Frankfort, which, from the account given of it by our special correspondent, Prof. R. O. Heinrich, evidently contains much that has never been publicly shown before, and hence offers a most valuable opportunity for study and the comparison of present methods and apparatus. Prof. Heinrich's subsequent communications will deal in detail with the Frankfort exhibits, and our readers will therefore be placed in a favorable position to judge of the progress made and to have a permanent record of it. Although American progress in the industrial applications of electricity would long since have warranted the holding of another electrical exhibition in this country, there is little doubt that the Chicago World's Fair will, in due time, afford adequate opportunity for a fitting exhibition of our advance and achievements.

THE ARGUMENTS IN THE INCANDESCENT LAMP CASE.

IT is by no means an easy task to undertake to present to the readers of a technical journal, under the limitations of space which circumstances render unavoidable, an intelligible synopsis of more than 210,000 words of argument, emanating from half a dozen of the foremost legal minds of the day; but the vast importance of the interests which will be affected by the results of the litigation which has been in progress for the past six years over the incandescent lamp patent of Mr. Edison, has seemed to justify us in making the attempt. We are well aware that it is quite impossible, under such conditions, to make an adequate presentation of the legal points so forcibly urged upon the attention of the court by the learned disputants. The eloquent closing argument of Mr. Lowrey, which is begun in abstract elsewhere, especially suffers under the process of severe condensation to which it has been subjected, and to which it lends itself perhaps less readily than those of some of his colleagues. But as this is the only attempt which has been made by any journal to give even an approximately complete report of the proceedings in one of the most important trials in the annals of patent litigation, we trust that the results of our labor may prove to be not wholly without value.

CONDENSERS IN ALTERNATING CURRENT WORK.

ONE of the most noteworthy developments in the domain of alternate current working is the prominence which has been given within a comparatively short time to the condenser and its action in relation to circuits possessing high self-induction. Heretofore regarded seriously as a working device only by the telegraph and telephone engineer, the condenser has suddenly risen to occupy a place such that it would be difficult to predict to what uses it may hereafter be put. As another illustration of its present wide application we note this week its use by Mr. Tesla in his well-known alternating motor. In alternating motors of this type the induced circuit in the armature represents an inductive resistance which has a considerable value and which is constantly changing with the varying position of the coil with respect to the field magnets. Such a motor is virtually a transformer, and anything that tends to increase its output will, other things being equal, improve it. Evidently one of the chief requisites in a motor in which currents are induced in the armature is to pass through the armature circuit the greatest possible current which can be produced by a given impressed E. M. F., or, in other words, by a given inductive effect of the field. Mr. Tesla accomplishes this by placing a condenser in the armature circuit, thereby counteracting the self-induction and hence permitting a larger volume of current to pass through the induced circuit. In order to permit of the rotation of the condenser Mr. Tesla places it in the armature, or very ingeniously connects the armature plates so as to form a condenser. Mr. Tesla, we may add, also uses a like connection in other forms of induction apparatus, such as converters.

OUTLOOK.

The suspension of the Empire City Electric Company and its proceedings for a voluntary dissolution and liquidation of its business led a New York daily newspaper to print, some days ago, a sensational article, in which an imaginative writer set forth " whispered " rumors and suspicions in "Wall Street" of an early collapse of other electrical companies on the ground that electrical manufacturing and trading was overdone and therefore unprofitable. The article contained a further tale of the attempted formation of a trust by a considerable number of more or less prominent electrical supply houses. The trust was to control prices in some measure and to restrict production, or, at least, to limit the accumulation of stocks by the several members of the combination.

The officers and directors of the Empire City Company admit the unprofitableness of their business for some time past, and deliberately prefer to liquidate rather than to invest more capital and continue under existing conditions. They estimate their resources as sufficient to pay creditors nearly if not quite in full. Their course in dissolving voluntarily would seem to be a commendable one. Meantime rumors and reports of various sorts are current touching attempts to form some kind of an agreement among a number of large supply houses, East and West, looking to community of action in purchasing and in keeping selling prices up to paying rates.

Several companies of less prominence have failed during the last few months and have gone out of business or are now liquidating. Among the large electric manufacturing companies the Westinghouse Company which has been in serious difficulty for some eight months, seems now likely to emerge in good position to hold its own and to augment its large business. It is now understood that shareholders, to more than the amount required, have assented to the reorganization scheme promulgated some months ago. The consummation of the plan, which has heretofore been set forth in this journal, may fairly be expected to enable the company, under conservative and judicious management, to go forward upon an improved and sounder financial basis in the work it has so energetically undertaken of supplying alternating current apparatus and electric railway machinery. A final collapse of the Westinghouse electric interests, while temporarily eliminating a formidable competitor, would, no doubt, react unfavorably upon other prominent manufacturing companies through its tendency to induce distrust of electrical industry generally on the part of the public and of investors. Their rehabilitation, now apparently assured, should enhance general confidence in the merit of electrical business as a legitimate and reasonably profitable field for the employment of capital and of administrative ability.

Touching the opinion that electrical manufacturing and trading are overdone, it may be remarked that it would be much nearer the truth to say that they have too often, from the start, been *badly* done. We refer less to the quality of products than to the organization and business methods employed in marketing them. We have not yet, perhaps, wholly left behind the period for conjuring with the word " electrical," for pretending to believe and trying to make others believe, that there is some magic in electricity that will ensure the success of any scheme to employ its seeming marvels as a foundation for business. Patents for electrical inventions, sometimes of value sufficient to justify the investment of a few thousand dollars and the setting up of a modest business, have become at the hands of too enterprising or too sanguine promoters the principal assets of companies capitalized at $500,000 or $1,000,000 and decorated with a president, board of directors, and an executive staff. The inventor gets some shares of stock, probably a good many, perhaps not so many as the promoters ; the skillful use of the word "electrical," in the company's name, evokes from the pockets of a few outsiders some hundreds or thousands of dollars for " working capital," and all starts merrily off. The end in a year or so is not so merry. There have been no profits, the " working capital " has been expended and no more is forthcoming; then " this company regrets to inform its creditors, etc., etc." If the promoter have been sagacious enough he will have sold his shares some time ago ; the inventor will very likely have treasured his, and have done his best to make things go. Creditors take what they can get ; shareholders get nothing ; officers, staff, and employees are out of a job, and meritorious electrical concerns have to share in some measure the discredit thrown upon the trade in general. Happily it is becoming more and more difficult to float electrical enterprises that will not bear expert examination, both technical and financial. Good business principles and sound financiering are seen to be quite as indispensable to continued success in the electrical field as in any other department of industry and commerce.

ANTI-INDUCTION TELEPHONE DEVICES.

The almost unbroken series of decisions sustaining the rights of electric railway companies to operate their wires in the streets of cities, notwithstanding the prior occupation of such public highways by telephone lines and the interference caused by induction, has probably by this time brought the telephone companies to a realization of the fact that their remedy does not lie so much in the direction of the courts as in their own hands by the application of well-known methods. The metalic circuit, while all-sufficient for practical purposes, necessarily involves an expense which the telephone companies desire, if possible, to avoid, and many have been the " anti-induction " devices proposed and tried on single lines with earth return. But none of these so far as we are aware has yet proved successful enough to warrant its general adoption, so that the field in this direction is still open to all. Bent evidently upon removing even this smallest objection to the electric railway, Prof. Elihu Thomson has recently worked upon a method, described on another page, in which, by introducing a suitable counter E. M. F. device influenced by the same disturbing cause, the disturbing currents on the main line are neutralized.

ON ELECTRICAL EVAPORATION.[1]

BY WILLIAM CROOKES, F. R. S.

It is well known that when a vacuum tube is furnished with internal platinum electrodes, the adjacent glass, especially near the negative pole, speedily becomes blackened, owing to the deposition of metallic platinum. Whilst a solid body like platinum requires an intense heat to enable its upper stratum of molecules to pass beyond the sphere of attraction of the neighboring molecules, experiment shows that a very moderate amount of negative electrification superadds sufficient energy to enable the upper stratum of metallic molecules to fly beyond the attractive power of the rest of the metal. I have recently made some experiments upon the evaporation of different substances under the electric stress.

Evaporation of Water.—A delicate balance was taken, and two very shallow porcelain dishes were filled with acidulated water and balanced on the pans. Dipping into each dish—touching the liquid, but not the dish—was a platinum wire, one connected with the induction coil and the other insulated.

It was found that *negatively* electrified water lost in 1¼ hours $\frac{1}{1000}$ part of its weight more than did insulated water. This experiment shows that the disturbing influence which assists evaporation is peculiar to the negative pole, even at atmospheric pressures.

The metal cadmium was next experimented upon.

Evaporation of Cadmium.—If the flying-off of the metal of the negative pole is similar to evaporation or volatilization the operation should be accelerated by heat.

A tube was made as shown in Fig. 1. A and B are the platinum poles sealed through the glass. C and D are two blocks of metallic cadmium of the same size and weight. The piece C is in contact with the pole B, which in the experiment was always kept negative, the pole A being positive. When the exhaustion was such that the passage of the current gave green phosphorescence over the glass, heat was applied simultaneously to both ends of the U-shaped tube by means of a gas-burner and air-bath, so that one piece of cadmium was at the same temperature as the other. The current was then applied and was kept on for about an hour, and it was remarkable that no metal was deposited in the neighborhood of the positive pole, the surrounding portion of the tube being quite clean, while the corresponding part of the other limb of the tube having no electrodes, was thickly coated, the appearance being shown in the drawing.

As the temperature was high, metal had distilled off from both lumps; hence there was no visible difference in the amount of the deposit in the two sides. It is evident that, to render the electrical action most visible, the temperature should be kept short of the normal volatilizing point.

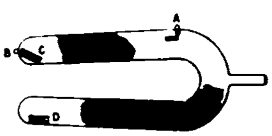


FIG. 1.

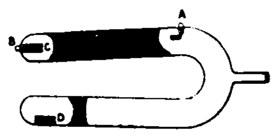


FIG. 2.

In the next experiment an exactly similar tube was used; the vacuum was such that the green phosphorescence of the glass was well seen, the temperature was kept just below the melting point of cadmium, and the current was kept on for an hour. On examining the tube at the end of this time, the appearance was as seen in Fig. 2. A considerable deposit had taken place on the end of the tube near the negative pole, the space round the positive pole was clear, while in the limb of the tube where no electricity had been passing only a very little deposit of metal was seen, as shown in the figure.

Another tube was made as shown in Fig. 3. The poles A, B, C, D, were platinum wires sealed through the glass, A and D having aluminum poles covering the platinum wire. In the ends of the tube, and touching the poles B and C, were two pieces of cadmium of the same size and shape. The tube was exhausted to the phosphorescent point, and the current was turned on, C being made negative and D positive. No heat was applied. The current was kept on for about half an hour, until a good deposit of metal had been deposited on the glass, the appearance being as shown in Fig. 4, the glass near the pole C being coated with metal, while the glass round the pole D was clean. The outer boundary of the dark space during the experiment is shown by the dotted line *e f*.

The pole B was now made positive, and pole A negative, the current being kept on for another half hour, At the end of the time the only additional effect was a slight darkening round the lump of cadmium, in the same place as, but very much fainter than, the deposit shown in Fig. 5. This is probably due to a little leakage of negative discharge from the positive pole. The experiment shows that positive electrification does not cause the metal sensibly to volatilize.

In these experiments no estimation was made of the weight of metal removed. To render the experiment quantitative, and at the same time to remove any disturbing effect that might be caused by heating at the point of indifferent contact, the following experiments were made:

A U-shaped tube, Fig. 6, had a platinum pole sealed in each end. Six grains of pure cadmium were put into each limb and fused round the platinum wire. The ends of the tube were then put into an air-bath, and kept at a temperature of 200°C. during the continuance of the experiment. The exhaustion remained at 0.00076mm., or 1 M. The induction current was kept going for 35 minutes. At the end of this time it was seen that most of the cadmium had disappeared from the negative pole, leaving the platinum wire clean, no metal being deposited near it, and the

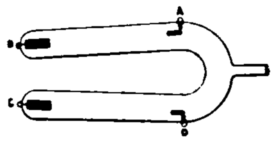


FIG. 3.

FIGS. 4 AND 5.

molecules appearing to have been shot off to a distance of about ¾in. The appearance of the postive pole was very different; scarcely any of the cadmium had been volatilized, and the condensed metal came almost close to the pole. The tube was opened, and the remaining wires and metal were weighed. The cadmium was then dissolved off the poles in dilute acid; the residue was washed, dried, and weighed.

	Positive pole.	Negative pole.
Original weight of cadmium......	6.00 grs.	6.00 grs.
Cadmium remaining on the pole...	3.65 "	0.25 "
Cadmium volatilized in 35 mins....	2.35 "	5.75 "

The difference between the amount of cadmium driven from the two poles having proved to be so decided, another experiment was tried in a tube so arranged that the metal could be more easily weighed before and after the experiment. The apparatus is shown in Fig. 7. A tube is blown U-shaped, having a bulb in each limb. The platinum poles were, as before, at the extremities of each limb, and in each bulb was suspended from a small platinum hook a small lump of cadmium, the metal having been cast onto the wire. The wires were each weighed with and without the cadmium. The tube was exhausted, and the lower half of the tube was enclosed in a metal pot containing paraffine wax, the temperature being kept at 230° C. during the continuance of the experiment. A deposit around the negative pole took place almost immediately, and in five minutes the bulb surrounding it was opaque with deposited metal. The positive pole with its surrounding luminosity could be easily seen the whole time. In 30 minutes the experiment was stopped, and after all was cold the tnbe was opened and the wires weighed again. The results were as follows:—

	Positive pole.	Negative Pole.
Original weight of cadmium........	9.34 grs.	9.38 grs.
Weight after experiment	9.25 "	1.86 "
Cadmium volatilized in 30 mins. ..	0.09 "	7.52 "

Finding that cadmium volatilized so readily under the action of the induction current, about 350 grains of the pure metal was sealed in a tube, and the end was heated to a little above the melting point.[2] The whole volatilized and collected at the opposite (positive) end, without touching the pole.

Volatilization of Silver.—Silver was the next metal experimented upon. Small lumps of pure silver were cast on the ends of platinum wires, and suspended to the inner ends of platinum terminals passing through the glass bulb. The platinum wires were protected by glass, so that only the silver balls were exposed. The whole apparatus was enclosed in a metal box lined with mica, and the temperature was kept as high as the glass would allow without softening. The apparatus was exhausted to a dark space of 3mm., and the current was kept on for 1¼ hours. The weights of silver, before and after the experiment, were as follows:—

	Positive pole.	Negative pole.
Original weight of silver............	18.14 grs	24.63 grs.
Weight after the experiment.......	18.13 "	24.44 "
Silver volatilized in 1¼ hours.......	0.01 "	0.19 "

It having been found that silver volatilized readily from the negative pole in a good vacuum, experiments were instituted to

1. Abstract of a paper read before the Royal Society, June 11, 1891.

2. Cadmium melts at 320° and boils at 860°.

ascertain whether the molecules of metal shot off from the pole were instrumental in producing phosphorescence. A glass apparatus was made as shown in Fig. 8. A pear-shaped bulb of German glass has near the small end, an inner concave negative pole, A, of pure silver, so mounted that its inverted image is thrown upon the opposite end of the tube. In front of the pole is a screen of mica, having a small hole in the centre, so that only a narrow pencil of rays from the silver pole can pass through, forming a bright spot of phosphorescence, D, at the far end of the bulb. The exhaustion was pushed to a high point, 0.00068mm., or 0.9 M. The current from an induction coil was allowed to pass continuously for some hours, the silver pole being kept negative, so as to drive off a certain portion of the silver electrode. On subsequent examination it was found that the silver had all been deposited in the immediate neighborhood of the pole, whilst at the far end of the tube the spot D, that had been continuously glowing with phosphorescent light, was practically free from silver.

A tube was next made as shown in Fig. 9. It had two negative poles connected together, A, A′, so placed as to project two luminous spots on the phosphorescent glass of the tube. One of the electrodes, A′, was of silver, a volatile metal; the other, A, was of aluminum, practically non-volatile. On connecting the two-negative poles, A, A′, with one terminal of the coil, and the positive pole, B, with the other terminal, it was seen in the course of half an hour that a considerable quantity of metal had been projected from the silver negative pole, blackening the tube in its neighborhood, while no projection of metallic particles took place from the aluminum positive pole. During the whole time of the experiment, however, the two patches of phosphorescent light, C and C′, had been glowing with exactly the same intensity, showing that the active agent in effecting phosphorescence was not the molecules of the solid projected from the poles, but the residual gaseous particles, or "radiant matter."

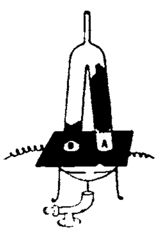


FIG. 6.

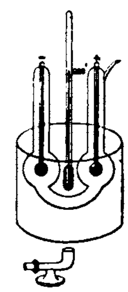


FIG. 7.

In the tubes hitherto made containing silver, it had not been easy to observe the spectrum of the negative pole, owing to the rapid manner in which the deposit obscured the glass. A special tube, Fig. 10, was therefore devised of the following character. The silver pole A was attached to the platinum pole at one end of the tube, and the aluminum positive pole, B, was at the side. The end of the tube opposite the silver pole was rounded, and the spectroscope was arranged to observe the light of the volatilizing silver "end on," as shown in the figure. In this way the deposit of silver offered no obstruction to the light, as none was deposited except on the sides of the tube surrounding the silver. At a vacuum giving a dark space of about 3 mm. from the silver, a greenish-white glow was seen to surround the metal. This glow gave a very brilliant spectrum. The spark from the silver poles in air was brought into the same field of view as the vacuum glow, by means of a right-angled prism attached to the spectroscope, and the two spectra were compared. The two strong green lines of silver were visible in each spectrum; the measurements taken of their wave-lengths were 3,344 and 3,675, numbers which are so close to Thalén's numbers as to leave no doubt that they are the silver lines. At a pressure giving a dark space of 2 mm. the spectrum was very bright, and consisted chiefly of the two green lines and the red and green hydrogen lines.

If, for the negative electrode, instead of a pure metal such as cadmium or silver, an alloy was used, the different components might be shot off to different distances, and in this way make an electrical separation—a sort of fractional distillation. A negative terminal was formed of clean brass, and submitted to the electrical discharge *in vacuo;* the deposit obtained was of the color of brass throughout, and on treating the deposit chemically I could detect no separation of its component metals, copper and zinc.

If we take several liquids of different boiling points, put them under the same pressure, and apply the same amount of heat to each, the quantity passing from the liquid to the gaseous state will differ widely in each case. It was interesting to try a parallel experiment with metals, to find their comparative volatility under the same conditions of temperature, pressure, and electrical influence. It was necessary to fix upon one metal as a standard of comparison, and for this purpose I selected gold, its electrical volatility being great, and it being easy to prepare in a pure state.

An apparatus was made with four negative poles at one end and one positive pole at the other, shown in Fig. 11. By a revolving commutator I was able to make electrical connection with each of the four negative poles in succession for exactly the same length of time (about six seconds); by this means the variations in the strength of the current, the experiment lasting some hours, affected each metal alike. The exposed surface of the various metals used as negative poles was kept uniform by taking them in the form of wires that had all been drawn through the same standard hole in the drawplate, and cutting them by gauge to a uniform length; the actual size used was 0.8 mm. in diameter, and 20 mm. long. The comparison metal, gold, had to be used in each experiment; the apparatus thus enabled me to compare three different metals each time. The length of time that the current was kept on the revolving commutator in each experiment was eight hours, making two hours of electrification for each of the four negative electrodes; the pressure was such as to give a dark space of 6 mm.

The following table of the comparative volatilities was in this way obtained, taking gold as = 100:

Palladium	108.00	Platinum	44.00
Gold	100.00	Copper	40.24
Silver	82.68	Cadmium	31.99
Lead	75.04	Nickel	10.99
Tin	56.96	Iridium	10.49
Brass	51.58	Iron	5.50

In this experiment equal surfaces of each metal were exposed to the current. By dividing the numbers so obtained by the specific gravity of the metal, the following order is found:

Palladium	9.00	Cadmium	3.72
Silver	7.88	Copper	2.52
Tin	7.76	Platinum	2.02
Lead	6.61	Nickel	1.29
Gold	5.18	Iron	0.71
Iridium	0.47		

Aluminum and magnesium appear to be practically non-volatile under these circumstances. The order of metals in the table shows at once that the electrical volatility in the solid state does not correspond with the order of melting points, of atomic weights, or of any other well-known constant.

It is seen in the above table that the electrical volatility of silver is high, while that of cadmium is low. In the two earlier experiments, where cadmium and silver were taken, the cadmium negative electrode in 30 minutes lost 7.52 grs., whilst the silver negative electrode in 1¼ hours only lost 0.19 gr. This apparent discrepancy is easily explained by the fact (already noted in the case of cadmium) that the maximum evaporation effect, due to electrical disturbance, takes place when the metal is at or near

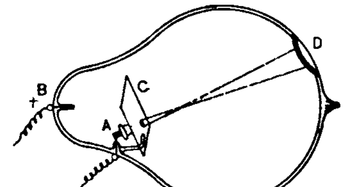


FIG. 8.

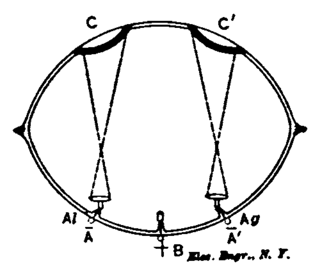


FIG. 9.

the point of liquefaction. If it were possible to form a negative pole *in vacuo* of molten silver, then the quantity volatilized in a given time would be probably much more than that of cadmium.

Gold having proved to be readily volatile under the electric current, an experiment was tried with a view to producing a larger quantity of the volatilized metal. A tube was made having at one end a negative pole composed of a weighed brush of fine wires of pure gold, and an aluminum pole at the other end. The tube was exhausted and the current from the induction coil put on, making the gold brush negative; the resistance of the tube was found to increase considerably as the walls became coated with metal, so much so that, to enable the current to pass through, air had to be let in after a while, depressing the gauge ½mm. The weight of the brush before experiment was 35.4949 grs. The induction current was kept on the tube for 14½ hours; at the end of this time the tube was opened and the brush removed. It now weighed 32.5613, showing a loss of 2.9327 grs. When heated below redness the deposited film of gold was easily removed from the walls of the tube in the form of very brilliant foil. After having been subjected to electrical volatilization, the appearance of the residual piece of gold under the microscope, using a ¼ in. object glass, was very like that of electrolytically deposited metal, pitted all over with minute hollows.

This experiment on the volatilization of gold having produced good coherent films of that metal, a similar experiment was tried, using a brush of platinum as a negative electrode. On referring to the table it will be seen that the electrical volatility of platinum is much lower than that of gold, but it was thought that, by taking longer time, a sufficient quantity might be volatilized to enable it to be removed from the tube. The vacuum tube was exhausted to such a point as to give a dark space of 6mm., and it was found, as in the case of gold, that as a coating of metal was deposited upon the glass the resistance rapidly increased, but in a much more marked degree, the residual gas in the tube apparently becoming absorbed as the deposition proceeded. It was necessary to let a little air into the tube about every 30 minutes, to reduce the vacuum. This appears to show that the platinum was being deposited in a porous, spongy form, with great power of occluding the residual gas. Heating the tube when it had become in this way non-conducting, liberated sufficient gas to depress the gauge of the pump 1mm., and to reduce the vacuum so as to give a dark space of about 3mm. This gas was not re-absorbed on cooling, but on passing the current for 10 minutes the tube again refused to conduct, owing to absorption. The tube was again

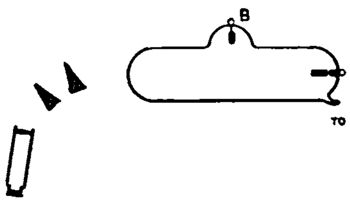


FIG. 10.

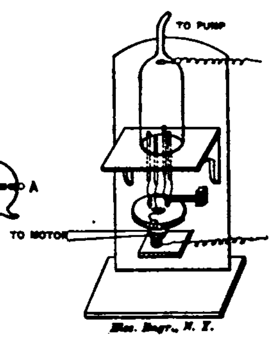


FIG. 11.

heated, with another liberation of gas, but much less than before, and this time the whole was re-absorbed on cooling. The current was kept on this tube for 25 hours; it was then opened, but I could not remove the deposited metal except in small pieces, as it was brittle and porous. Weighing the brush that had formed the negative pole gave the following results:

	Grains.
Weight of platinum before experiment..........	10.1940
" " after experiment..........	8.1570
Loss by volatilization in 25 hours...............	2.0370

Another experiment was made similar to that with gold and platinum, but using silver as the negative pole, the pure metal being formed into a brush of fine wires. Less gas was occluded during the progress of this experiment than in the case of platinum. The silver behaved the same as gold, the metal deposited freely, and the vacuum was easily kept at a dark space of 6mm. by the very occasional admission of a trace of air. In 20 hours nearly 3 grs. of silver were volatilized. The deposit of silver was detached without difficulty from the glass in the form of brilliant foil.

ELECTRIC NIGHT SIGHT FOR ORDNANCE.

The British Navy Department are using illuminated night sights on many of the guns of their war ships The sights are so constructed that they can be put on or removed in short time. The front sight consists of a metal socket inclosing a very small cone of pale-green glass, point up, and with only the rear half showing. A small incandescent light is placed under this cone, the light from which shines up through the base of the cone and is then reflected to the rear. The rear sight is similar except that instead of the cone there is a metal cross-bar with a V notch in the middle and a polished under surface, from which the light, which first passes through a ruby-colored glass, is reflected. In sighting, the point of pale-green light is brought to the bottom of the V notch and the line of ruby-colored light brought into coincidence with it. The electric current used is local for each gun, and is supplied by a battery of two elements contained in a water-tight box, so arranged that when turned upside down the battery is out of action and can be kept so until the sights are needed for use. The light can be brightened or dimmed.

Legal Notes.

EDISON INCANDESCENT LAMP LITIGATION—V.

CLOSING ARGUMENT OF GROSVENOR P. LOWREY, ESQ., FOR THE EDISON CO.

UPON the opening of court on June 3d, the closing argument for the complainants' was commenced by Grosvenor P. Lowrey, Esq. Mr. Lowrey commenced by saying that he regarded this contest as the most dignified and the most important one in which he had ever taken part; that he never expected to be engaged in another one comparable with it in dignity and importance. It was a great cause; whether they regarded the subject, which was great and complex, or the vast pecuniary interests, or the personal fame and noble ambitions of inventors and men of science which it involved. The truth of history was in issue, and future generations had a right to know it. It was a controversy prosecuted in the presence of a great tribunal, holding its commission to decide with all the sanction which the highest civilization, exerting itself through the most perfect system of laws, could give. The investigation which it was his Honor's duty to conduct must be cold and impartial, the judgment must be pronounced without reference to the extent of interests involved, without reference to consequences, however vast or however complex, for it was after all only a question of law. Certain elements had affected the case which could not be fully revealed to his Honor in the record, and yet could not be concealed. They were here dealing with interests in which personal feeling had become involved, and which had given to all in the case a certain color. They were not only dealing with the question of who had actually made the incandescent lamp and had obtained the patent in suit, but with the fact that there had been a resolute and persistent denial from the beginning, by a rapidly decreasing number of persons, of the just title and fame of Mr. Edison. He (Mr. Lowrey) represented a man who most of the world considered a great inventor and benefactor. The few remaining who still persisted in the contrary belief were nearly all present in that room, or in the record as witnesses for the defence. It was fair that an inventor should be weighed in a balance fitted to weigh the fine spiritual work of genius. Genius never intimated nor judged; it perceived. Lord Bacon had said:

> "The introduction of great inventions appears one of the most distinguished of human actions, and the ancients so considered it; for they assigned their divine honors to the office of invention, but only heroic honors to those who displayed civil merit; such as the founders of cities and empires, legislators, the deliverers of their country from lasting misfortunes; the quellers of tyrants and the like. And if any one rightly compare them, he will find the judgment of antiquity to be correct; for the benefits derived from inventions may extend to mankind in general, but civil benefits to particular lands alone; the latter, moreover, last but for a time, the former forever. Civil reformation seldom is carried on without violence and confusion, while inventions are a blessing and a benefit, without injuring or afflicting any."

There was now presented to his Honor the question, whether a man whom Lord Bacon's description clothed with striking aptness, after years of struggle and endeavor, and in full view of the great benefits conferred by him on mankind, could by a petty parsing and spelling of things; a subtle analysis of words and sentences composed in a patent solicitor's office; and especially words devised touching a subsequent application, lose the invention he had given to the world. Mr. Edison was a character quite unique and unprecedented in the history of the art. No wonder he had startled the idiots of the schools, and excited the animosities of men who teach to unresisting boys the knowledge, as well as the errors, found in books.

Endowed by nature with rarest faculties of observation; capable of realizing beforehand all that was to take place in any hitherto hidden physical action; with highest courage and enthusiasm; indomitable energy; capacity of concentration equal to that of the microscope; and notwithstanding the reprehensible suggestion of his friend Gen. Duncan,—a man whose modesty and intellectual honesty were as monumental as his constructive genius; a man most unjustly and insultingly derided by those who were as incapable of understanding him as they were of doing him justice. Edison had been an inventor by nature and from the beginning. His first thought had been a question; his constant tendency to remedy that which was deficient. He was not to be spoken of as an electrical engineer; nor yet as a philosophical discoverer; he was a commercial and industrial inventor, whose sole object it was to make things useful to mankind, taking his fair reward, as every laborer took his hire. To him, an abstract principle incapable of being applied to ameliorate some condition of human life, was as valueless as a cup of water thrown into a lake. Why go after that water? Mr. Edison runs quickly to the overflow, catches it there and uses it to turn a mill.

Bear in mind that he was not a reader of books, in the ordinary sense, neither was he an absorber nor derider of other men's ideas, not that he despised books, but his impulse was if the books said a thing could not be done to say: Don't stop with that, but try to do it. And one result of not stopping, but of trying to do things declared to be impossible, has been this electric light, and many other inventions given to the world by him. Mr. Edison had perhaps the most valuable private scientific library in the world, but he was no slave to books. He (Mr. Lowrey) had heard him say "It is a poor nature that has not got this thing in it; and if it has, give us time and don't bother us with books, and we will find it." That was the kind of man towards whom the scientific experts of the other side had been particularly contemptuous from the beginning; that was the kind of man who had given to mankind what he should sometimes call the "light of the patent" and sometimes the "Edison light"—in his construction absolutely synonymous terms. That was the man who stood for the moment, with the chance of losing his invention after he had made it, and gone away to other works, by some trifling pen-and-ink business in the shop routine of a patent solicitor's office.

His brother, Wetmore, with an art and judgment which it had not needed this case to give him a reputation for, had reserved until the last his most effective word. The effect produced upon him (Mr. Lowrey) had been like one of those sudden attacks of illness which when taken at once was easily controlled, but, otherwise was liable to result in constitutional difficulties which might take a great deal of skill to remove. He hoped to be able to disperse whatever ill influence that argument might have had, and although it was to the utter disordering of all his plans, he should devote himself first to the divisional application of 1880, and afterwards to his brother Betts and his eccentric understanding of the English decisions.

The question immediately under consideration was whether, as the defendants had asserted, when Mr. Edison had talked about a burner and a lamp, he had meant only a lamp in which the burner was made in a coil; or whether, as complainants contended, he had meant a lamp in which the burner was in whatever form was useful, as falling within the general and sufficient language of the art. His brother, Wetmore, was like that serpent which carried its sting in its tail; he had given them the last thrust, and it was a sharp one. He had proposed to read from a paper for which Mr. Edison was, as he thought, in his conscience and personally responsible, words which he (Mr. Lowrey), had never heard of before, and it seemed to him at first hearing to put Mr. Edison in an inconsistent position, and as displaying a motive which would justly rob him in a degree of his honor's esteem. His brother, Wetmore, had said: "In their sworn specification, in which they state that claim now pending before the Patent Office, and referring to this patent, they say:

'In my patent No. 223,898 is described and shown a lamp which meets all the conditions of commercial manufacture and use but has the disadvantage of being provided with a closely coiled filament, parts of which do not radiate available light but serve to heat other parts of the filament resulting in an intensely concentrated light which is disagreeable to the sight. The loop or horseshoe filament of my present lamp is more convenient and economical in manufacture and radiating available light throughout the length of its incandescent portion, a lamp which is better adapted for general use.'

Mr. Wetmore's statement that this language was contained in the sworn specification of Mr. Edison was true in a false sense; it was true that such words were in the specification; they had been actually inserted by amendment seven years after the specification had been sworn to, and entirely without Mr. Edison's knowledge. They had been inserted by his attorney, Mr. Dyer. One Mr. Serrell, a very respectable practitioner, had drawn the specification for the patent in suit; then Mr. Z. F. Wilber, now dead, had become the solicitor of Mr. Edison. He could conceive that Mr. Wilber's first work had been to look around and see how he could magnify his own merit by finding things by his predecessor left undone and to be done. He had found on file in the Patent Office an application for a patent on paper carbon. It had then contained nothing inconsistent with the patent in suit. In December, 1880, Mr. Wilber, as he (Mr. Lowrey) might fancy, having found his opportunity to show how great a man he was, had added the claims now thought to be inconsistent with the idea Mr. Edison had, when he took out the patent in suit. Even if it should be found that there were differences between the pending application so called (in fact it was not pending, it had long been dead) and the claims of the patent in suit, he supposed it was not forbidden to an active-minded man like Mr. Edison to change his mind with respect to the invention.

His Honor remarked that he did not think it important as bearing upon the construction of the patent in suit whether the application referred to was dead or not.

Resuming, Mr. Lowrey said that the application had proceeded to a consideration three times by the Commissioner of Patents. In its last decision the Office had held the invention to be identical with that shown, described and *claimed* in the patent in suit; so there had been a judicial construction, and a decision that had ended the controversy, to the effect that the patent in suit was like the application on which Mr. Wilber had sought to obtain for Mr. Edison a patent. They had, therefore, only to deal with a mixed, moral and equitable question: whether Mr. Edison, through Mr. Wilber, thought differently at different times, as to what was the legal construction of a paper, was, after all his great labors, to lose the fruits of them, for such a reason as that.

He would compare the divisional application with the patent in suit, and by a critical analysis endeavor to satisfy his Honor that there was nothing in the question which had been made thereon, and never had been anything in it than color and pretense.

Mr. Lowrey then entered at considerable length into a comparison of the pending divisional application with the patent in suit, and commenting thereupon, contended that Mr. Edison's act in making his application of December, 1880, could not in any way aid the Court in construing the claims of the patent in suit. He said that the complainant might safely admit, for the sake of argument, that the first claim of the application of December, 1880, was identical with complainant's construction of the first claim of the patent, and that the fifth claim of the application was identical with the second claim of the patent; and still maintain that Mr. Edison's act in making that application had not proved that he had not intended to make the first two claims of the patent in suit bear the construction for which the complainants were now asking, and for which they had always contended. They were to inquire what Mr. Edison had intended at that time; not what he had thought after he had changed his mind. The facts would, at most, show that thirteen months after making the claims for the patent in suit, Edison had come to fear that they might be construed more narrowly than he had originally intended to make them, and to fear that the utmost subtlety might be employed to attack his claims, and that he ought to protect his invention by a subordinate patent. It is conceivable that such a fear, if Mr. Edison had entertained it in December, 1880, might have arisen entirely out of rumors which might have come to his ears, of arguments in favor of unduly narrowing the construction of those claims; such arguments, perhaps, as those which had here been presented by defendant's counsel.

There was nothing of value in the present discussion, except to find out what Mr. Edison had meant; and certainly no intention could be inferred from facts which, as he says, had been unknown to him. Therefore, when they came to what he had said when Gen. Duncan examined him; when he had remarked, with a good deal of emphasis, that he did not understand Ohm's law; it was the answer of a scholar and of a philosopher. His brother Duncan had spoken of it to his Honor in a tone of contempt. Mr. Edison was not merely not an "expert," but he was not one of that class to whom he (Mr. Lowrey) was going to give a fitting name. There had been some experts in this case who were entitled to be distinguished above the rest of their class; they were "expert experts;" Mr. Edison had encountered one of those, and could not answer his questions. Mr. Lowrey then read a long extract from the testimony of Mr. Edison, having reference to his personal knowledge of the contents of the amended divisional application, and proceeded to argue that it was evident that the opinions of Mr. Wilber, the attorney, could not have been based upon any information received from Mr. Edison, but had been formed entirely upon his own estimate of the significance of the words of the first claim of the patent in suit. While Mr. Wilber had been Mr. Edison's attorney for the purpose of making and altering applications for patent, he could have had no authority and no function for furnishing evidence out of his own mind as to the state of Mr. Edison's mind in the previous year. He thought that this whole business arising out of expressions in that divisional application had disappeared, but the pertinent question would be asked: If there was nothing in it, why had we fought so to keep it out of the evidence? His brother Seward, who had read the papers, had said there was nothing in them of legal significance; his brother Dyer had been indisposed to resist it; it had been an entire surprise to him (Mr. Lowrey) to find in the specification those words which did seem to involve a certain moral indirection; it had startled and alarmed him, for he desired his client to stand well in the appreciation of the Court, but he took all the blame upon himself; he had read an affidavit by Mr. Curtis who stated that he had learned from persons formerly employed in the Patent Office that there was a pending application on file, which, if it could be seen, he believed would be found to contain things useful to the defendants, and that they had asked to have those papers. Now, amiability of an extreme sort, like his own, might be presumed on too far, and that was really too much. An application had been made to his Honor for help to get at those papers, and subsequently, equally without success, to other courts, and finally they had subpœnaed complainants and they had brought those papers into court in a sealed box. He did not know what was in the box, but he did know that a man, whom he regarded as a vagrant and a foot-pad, was demanding to open the box to see, in the language of the affidavit, if there was not something there which they might, if they saw fit, put in evidence. If it was asked why they had resisted, it was in defense of personal rights; he trusted his Honor would not be prejudiced that they stood up for a legal right in the face of an outrageous and insulting demand. He implied no criticism upon the final judgment, it was right, because the Court had said it was right, but at the Court of Appeals he should speak again on that subject and with emphasis.

Mr. Lowrey said he would next give some attention to his brother Betts. Complainants were in possession of authority of such influence that he did not wonder defendants had deputed the most adept sapper and miner he knew of, to get under the

English decisions, and if his way of getting under had been a straight way, what he had said would have been very effective, but his brother Betts had undertaken to criticise the English decisions upon the general ground that while they were good enough decisions for the facts they had, they would not serve for the facts here. He said the English courts did not know that complainants had elsewhere patented the principle of high resistance and small radiating surface; that they did not know about the platinum patent, and that the German court did, and that made all the difference in the world; and that his Honor would have to put aside those English decisions as having been pronounced without sufficient knowledge of the facts. His brother Betts had not examined all the English cases. With what difficulty did we see things we were not looking for, and sometimes we did not see for a long time what we were looking for; an observation which had a good deal of point in reference to the slow development of electric light people who were so busy looking for certain particular things that they did not see certain other particular things.

Mr. Lowrey then read extracts from the decision of Mr. Justice Kay, and the record in the Holland (English) case, and concluded his comments thereupon, by observing that Mr. Betts had supported the corner-stone of his criticism upon the erroneous assumption that the English courts had not heard of the platinum patent, but that it must now be carted away and tumbled into the dock.

Mr. Edison's invention, said Mr. Lowrey, was divisible into parts which together constituted a history. In 1878 he had come from Ansonia, where he had seen for the first time an arc light of 4,000 c. p. He had thought about that lamp and had said to himself: "That is not illumination in the great and important sense. Ninety-five per cent. of the illumination is inside of houses; why does not somebody make a small lamp?" The answer which the state of the art had given him was: "You cannot make any small lamps; if you divide the light, the loss is so great there is no use of talking about it; it is not worth trying." He (Mr. Lowrey) wished to impress upon his Honor that the platinum, the carbon, and other lamps, were not interchangeable inventions; they were rather like grapes growing from one vine, each by its separate stem but all having a common root; a root first indicated in an article published in the New York *Sun*. The reporter tells us that Edison, after returning from Ansonia, experimented with electric lights. On Friday, Octobr 4th, 1878, his efforts were crowned with success, and the project that had filled the minds of scientific men for years was developed. "I have it now"—he said—"and singularly enough I have obtained it through an entirely different process than that from which scientific men have always sought to secure it." He had used the word "process." "With the process I have just discovered, I can produce 1,000—aye 10,000—from one machine; indeed, the number may be said to be infinite."

Probably he had not even got to the point of thinking what kind of a lamp he should make; but he had intellectually evolved the *process*. "The great loss of energy," said this practical and sane man, "is no loss, because there is no loss in not using a thing you do not want; what I want"—he said—"is ten lamps of ten c. p. each in place of a thousand c. p. lamp." The art had told him if he divided it he could not get ten lamps, for there would be no light in any of them. He reflected upon it, and because he was Edison, he saw at once the whole which happened afterwards, by way of trying lamps of platinum; of this thing and of that thing; which, although they each constituted a separate invention were one and all an exemplification of the discovery of the subdivision of the electric light. Mr. Edison had seen that to insure the independence of his separate lamps he must use the multiple-arc distribution; but the multiple arc was not claimed to be an invention of Mr. Edison. The laws of nature, as he might say in speaking of his friend Duncan's ingenious argument, had not been made by Mr. Edison; the credit for those laws still rested with God.

But then he had found a new trouble; when more lights were put on, more current must be supplied. Prof. Farmer had read a paper in 1879, and had said there was no trouble about the subdivision of the light if there was "enough conductivity;" that would do if one had enough copper, or enough money to get the copper, but nobody had enough.

Then had been evolved the Edison principle of applying resistance in the lamps, for the purpose of economizing copper, and at the same time of making each lamp independent.

That was the outcome of the visit to Ansonia; that was the process, which Mr. Edison had said was so simple that when the scientific world heard of it, they would wonder that they had not thought of it before. Of course the lamp was not then made; it was in the man's brain, but he saw it as clearly from that hour, as he had since seen it burning. They now knew, by various things that Edison did immediately afterwards in pursuance of it, that that process was nothing in the world but making a burner commensurate in radiating surface and in resistance, and any radiating surface whether highest or not, or any resistance, whether highest or not, which was adjusted to the purpose of achieving that economy, was a theft from Mr. Edison and an infringement of his patent. It was well known that the human mind was a very slow-acting machine; it did not usually see the things which lay just before it. Everyone acted under the sway of prejudgments about everything. We did not do many of the best things because we were under the sway of prejudice. Mr. Lowrey illustrated this point in a striking manner by reading an extract from the introductory remarks of Grove in his work on the "Correlation of Forces," in which, the author, speaking of the tendency of the human mind, when a new phenomenon was for the first time observed, to refer it to something previously known, observed that a theory is often put forth which shortly comes, for want of a better, to be admitted as an established truth; it is handed from father to son and gradually takes its place in education, but is nevertheless often prejudicial to the advance of science, inasmuch as theories the most immature, frequently become the most permanent.

There was a class of men, continued Mr. Lowrey, who, upon seeing a thing done, were able to believe that it ought always to have been done. Mr. Edison had been asked, referring to the leakage of the lamp chamber: "When you saw all that; the leakage, and the cause or defect; was it not obvious to cure it by fusing the parts together?" and he had replied: "Obvious! I don't know what you mean by 'obvious'; things are never 'obvious' to me until I see them." It was only to counsel and to expert experts that things are assumed to have been "obvious" before they could have been seen. His friends Dr. Cross and Dr. Morton had constructed for his Honor's benefit a lamp out of the laws of nature; his Honor would not be able to read anything by it, or to find anything in his room by it, but it was a good enough lamp for purposes of litigation. They had built it up from what one man knew about resistance, and another man knew about sealing glass globes; and they say now that it is entirely obvious that anybody could have made such a lamp if they had really had a call to do it.

It seemed there had been an error about the calling. The potential lamp makers had never been called, and the world has been without that light on account of the fault of that careless man, who had been charged with the responsibility, and who had overslept himself until Edison, not waiting for other call than the stirring of his own genius, had come. It had been the fashion to speak of this great man, Thomas A. Edison, as a charlatan, an ignorant man, a braggart. His Honor would find that to be the tone pervading the talk of many, who now seeing what has been done, wish that they had spoken more prudently in declaring what could not be done. Now, excepting Mr. Edison's answers to questions, excepting the letter he was about to read, and perhaps his paper before the scientific society, he did not know that all these seven volumes had given a glimpse of the real Edison, speaking for and by himself. Professor Morton had written to him, what he (Mr. Lowrey) thought was not an ingenuous letter. He had perhaps hoped to get Edison boasting on paper, so that he might sustain the notion of him derived from the absurd *Sun* article. In his answer you will see Thomas A. Edison; a modest, clean-cut, perfectly sincere man, a thousand fathoms deep all over, and yet thought by many people to be shallow. He says:

"Dear sir: Your favor of the 9th has just been received. The *Sun* article was somewhat exaggerated; but it is safe to say that I have some new ideas with regard to the electric light, more especially relating to the infinite subdivision of the same. I expect to put in at least six months' solid work perfecting it. Am just ordering a 50 h. p. engine for this line of experiment.

That was a block of Edison; a real specimen of the real man.

He would return for a short time to his brother Betts, who, by way of showing that plaintiffs had misrepresented the state of the art, had said that the whole subject of arranging lamps in multiple arc and series, and the making of an incandescent lamp of 10 ohms resistance, was in the Sawyer and Man patent of 1878. That statement was based upon a total misapprehension of the patent. It was principally a patent for a switch, and it stated that the resistance of the carbon when hot was ten ohms, and when cold, nil. He would pause to advise his brother Betts that he could not take his views with safety within the Sawyer and Man range; there was utter rottenness and ignorance throughout the whole. The thing which Professor Cross had told Mr. Betts when advising him upon the patent in suit, had been that carbon, when hot, has much less resistance than when cold. The statement that the carbon would acquire resistance when heated was entirely erroneous. Half-considered guesses were put on paper and filed in the Patent Office, and afterwards produced in court as a part of the state of the art. It was not impossible that a man might be hung on that kind of testimony if nobody looked into it. Professor Cross in his report on the state of the art which he had made to Mr. Betts on behalf of the Edison Company, had said that he was inclined to think that the number 10 ohms "had been stated at a venture." Of course it had been stated at a venture. Sawyer must have been in one of the conditions described by his associate on the stand, as "not lying," but probably in his other condition of "reckless drunkenness."

Mr. Sawyer was not so very much to blame, however, for being ignorant, for Prof. Farmer as late as 1879 had not struck upon the specific differences between hot and cold carbon in respect of resistance. Therefore, when you come to find Edison saying in his testimony that he found the resistance of a certain lamp to be about 100 ohms, and the matter being brought to his attention—whether he measured it cold or hot, he really does not know—it becomes clear that with none of the electricians had the point been as yet sharply focussed, and the matter of difference between cold and hot in resistance been definitely ascertained.

Starting out with Edison in 1878 upon that memorable search which resulted in the finding of the incandescent lamp, you will see that the first words from him indicate that he had an idea. He has got a process, and he believes it will take him six months to work it out. They would see him disappear underground, like a miner after a jewel, and while he was gone, they would take a little advice as to his prospects of success from the other people who were making search for the same jewel, and who were saving what a fool Edison was to go at all in that way. They would find that Morton, Preece and others had adopted the figures of Fontaine, and all the others, without a dissentient, except Sir William Thomson and Dr. Tyndall, were committed, after Edison was underground, to a statement posted above ground, that he had gone on a fool's errand. They had written across the path "no thoroughfare," and had signed it "Mathematicus." Mr. Lowrey then read several extracts, which have already become familiar in electrical literature, in confirmation of his statements. These great authorities in electricity and mathematics—said Mr. Lowrey—do not seem to be able to get outside of their figures and their equations. Professor Cross and Professor Morton had professed to be able to see what was not invention in a machine, although there was not in this case, nor probably elsewhere in the world, evidence which would convict either of those gentlemen of the possession of inventive capacity enough to hang a tin dipper on a pump.

Yet they had been called up with their pencils and their little pads to figure out that an invention like this, for which the whole world had been waiting, was after all no invention at all. It was difficult to select, there was so much of it, but Professor Silvanus Thompson was a striking example of how "away off," as the phrase was, all these people had been, about what was needed to make this light, and how Edison was going to do it. Mr. Lowrey then read from a letter of Professor Thompson the following extract:

> Much vagueness appears to exist in the minds of men upon the possibility of dividing the electric light indefinitely, and much has recently been said and written upon the question, which if tested by sober reasoning and by the application of elementary dynamical principles, will be found to be sheer nonsense. . . . . The reporter of the *New York Sun*, in his enthusiasm, puts into Mr. Edison's mouth statements which exhibit the most airy ignorance of the fundamental principles both of electricity and of dynamics.

There had been the first man to call Edison a fool. His Honor would see just how much one of the really instructed men knew or foresaw at that date. It was not ignorance; he knew all there was to be known. What was not known in the scientific world had been then developing in the brain of that ingenious man at Menlo Park. His Honor would see proofs of the influences arising out of preconceived opinions, driving everybody away from the course which Edison had taken. When Professor Thompson had said: "I cannot tell you what Mr. Edison's particular method of distributing the current of the spirals may be," he understood him to have expressed a difficulty that Mr. Edison or anybody else would have met in getting the current to the lamps; the principle of high resistance and small radiating surface having not yet reached the ears of these gentlemen. Professor Preece, too, had published another demonstration that it could not be done, because he did not know what it had been proposed to do. Preece had pointed out that with the machines then known, five or six lamps in series appeared to be about the limit of subdivision. "It is this partial success in multiplying the light"—says Preece—"that has led so many sanguine experimenters to anticipate the ultimate possibility of its extensive subdivision—a possibility which this demonstration shows to be hopeless and which experiment has proved to be fallacious." His friends on the other side had said that Preece was talking about series. Of course he was; there was nothing at that time to be talked about but series; the art had not yet conceived of multiple-arc distribution in connection with a practical light. Now Professor Morton, who was not at all limited in talking of his knowledge at any given date, provided he was speaking later than that date, after reciting previous failures, says:

> Familiar as is the fact that history repeats itself, we cannot but be struck with the many points of resemblance between the above, and what we read in the newspapers of to-day concerning the wonderful doings at Menlo Park, and must hope that Mr. Edison's invention will escape that permanent obscuration which seems to have finally shrouded M. de Changy's. . . . It is, as I understand, just here that Mr. Edison has made his much announced but carefully concealed invention. He has devised some simple and ingenious invention by which the solid conductor can be brought up to the highest point of incandescence without risk of fusion.

Now it was not uncommon for these experts, when attention was called to their incautious writings, to explain that of course they had not been talking about this or that, or else they would have said something different. Dr. Morton had thought that what Edison had done had been to invent a lamp that would not melt, and he showed very clearly that that had often been tried before, and omitted a little of his delicate sarcasm on the man who was fooling away his time trying to make a lamp that wouldn't melt, when there was that great question in mathematics, still unsolved. All these men had been "away off" from any true conception of the real difficulty, and from the real remedy, and would have stayed away off, forever. There had been absolutely no progress made in the right direction; what defendants had said about the state of the art was most admirable because it told of the absolute nothingness from which this man had started in the right direction. His direction was high resistance; and how did he achieve it? By a filament. What was a filament? A very thin long thing. Well, there had been King in 1845 who had a thin long ribbon of carbon; one could read through it. Well, one might read through a ribbon of carbon for a thousand years, and not get a filamentary structure for an electric light. The idea which had been pursued by Edison was economical and scientific. He sought high resistance accompanied by a relatively adjusted radiating surface, and having put those things together, he could cancel the orders on the copper merchant for so large a part of what had otherwise been necessary, that he could get money in Wall street with which to do business; something the mathematicians and the scientists had never thought of.

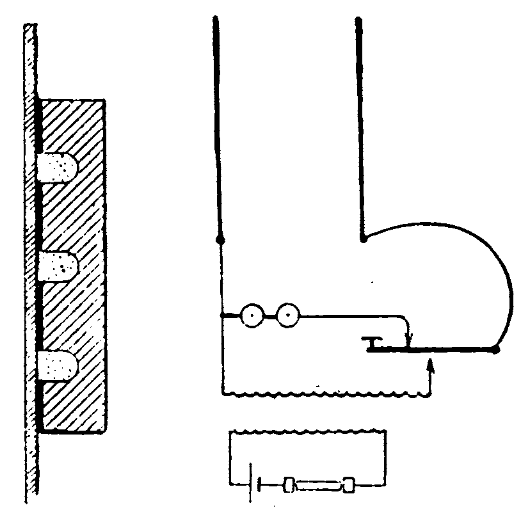
The defendants had labored quite uselessly to convince his Honor of what complainants would have conceded at any moment; that the platinum patent revealed all that was in the carbon patent, except that one crucial and all-resolving discovery, which notwithstanding the excellence of the platinum patent, was necessary to give the world electric lighting. His Honor had perhaps thought from the argument on the other side, that complainants were asking for a patent on those principles. They were supposing perhaps, that complainants were shut down to the mere discovery of the stability of carbon under certain conditions, so that if that did not involve patentable invention or discovery they had got nothing in the patent in suit. It would not be impossible to stampede the whole race of inventors, once the doctrine of interpretation which had insisted upon here should receive countenance by the Court.

(*To be concluded.*)

NOTE ON A MODIFICATION OF THE METHOD OF CONNECTING UP TELEPHONIC APPARATUS.[1]

BY E. MASSIN.

THE London-Paris telephone line was completed on Saturday, March 14th, by the laying of the submarine cable from Sangatte to St. Margaret's Bay. The following Tuesday the first experiment showed that success had crowned the enterprise, and that communication could be easily effected between the central offices.



FIGS. 1 AND 2.—MASSIN'S METHOD OF TELEPHONE CONNECTION.

All the instruments adopted in France for subterranean lines enabled conversation to be carried on more or less favorably. With the Gower-Bell, the Post Office instrument, communications were also exchanged without difficulty. Amongst the apparatus tried, the one which seemed to me to be the best, from the point of view of volume and clearness of sound, was the Roulez instrument.

In the Roulez instrument, the vibrating diaphragm is a carbon plate 10cms. in diameter. On this diaphragm is screwed a block of carbon 7cms. long, its face of contact being covered with a sheet of Bristol-board (Fig. 1), which acts as an insulator. The plate and block, insulated from one another by the Bristol-board, constitute the two poles of the microphone. The current gets from one pole to the other across fragments of incandescent lamp filaments arranged in three holes hollowed out of the carbon block and insulating sheet.

[1] *Annales Télégraphiques*, Vol. XVIII. Third Series.

I have stated that conversation was easy between the General Post Office and the Paris central office; but as soon as we added to the main line the high resistance gutta-percha covered cables which connect the central to the secondary offices, the state of affairs was altered, the voice was muffled, and while conversation was still practicable between two persons accustomed to converse by telephone, it was not, generally speaking, possible. If we took the most complex case, and tried to speak from a London subscriber's house to one at Paris, the voice was clear enough, but the volume of sound was insufficient for telephonic working.

With the existing urban lines only one apparatus was able to give the desired quantity and volume of sound, namely, the Roulez microphone, arranged in Fig. 2, where the receivers and the secondary of the induction coil are placed in parallel across the line. A special key closes the telephonic circuit, either of the receivers or of the secondary, but does not allow the two to be simultaneously to line. Instead of this arrangement, which was carried out in the apparatus employed at the Paris Observatory and the Treasury, one can keep both receivers and secondary in series and constantly in circuit, as is usually done, and content oneself by neutralizing one or the other of the two parts by short-circuiting them.

The theoretical advantages of the above modification of the usual arrangement are as follows: (1) The receivers do not spoil the transmission and the presence of the transmitter does not weaken the sound received; (2) the operator in the case of long lines does not have his ears deafened from the beginning by the currents generated by his own transmitter and traversing his receivers; (3) it is possible to increase the currents in the primary without fear of having currents in the microphone at the far end to cause troublesome crackling in the receivers at that end.

In the experiments between the Paris Observatory and the Treasury a battery of 10 Lalande cells arranged in series was used. With a *non-modified* Roulez this battery produced deafening cracklings in the receivers, and conversation was imperfect. But with the modified instrument conversation was perfect, the sound derived loud and clear, and one could even keep the receivers at some little distance from the ears and still perfectly understand what was being said.

This modification, therefore, possesses undeniable practical advantages. Applied to the Roulez instrument it increased the intensity of the sounds received at the Observatory and at the Treasury by 4 to 1, thus rendering conversation possible between a London Branch office and a Paris subscriber, to the exclusion of all other instruments tested. But the arrangement possesses two drawbacks, which are—firstly, the manipulation of the key; and, secondly, the impossibility of interrupting one's correspondent, who cannot be made to hear, so long as he is transmitting. The key is fitted in the handle of one of the receivers, and is manipulated with the thumb of the right hand; the button is pressed when transmitting, and freed when listening. This very simple manœuvre is easily learnt, and after two or three minutes' conversation the button is automatically moved without thinking. The impossibility of cutting into the conversation seems to me the only real disadvantage of the arrangement described, and we may ask whether this defect is not greatly compensated for by the increased range given to the telephone, and by the possibility of establishing communication between a Paris subscriber and a London branch office.

Letters to the Editor.

THE WINKLER DYNAMO.

In your issue of July 8th, Mr. F. A. La Roche, of Philadelphia, states that he fails to see the novelty of my dynamo as described in your issue of June 24th.

Mr. La Roche would be justified in denying any novelty if the claim were, as he seems to think, merely for a division of an ordinary armature winding between two commutators, as such a device is very old, antedating Mr. La Roche's experiment some years, and the disadvantages of which are well recognized.

My invention consists in utilizing part of the iron in the core of a Siemens drum to form a Gramme ring, or *vice versa*, the field taking its current from the latter, which, forming part of the magnetic circuit, thus answers a double purpose.

By so doing, valuable wire surface is gained, the air-gap is considerably reduced, the resistance of the copper-winding of the armature made a minimum, and the resultant resistance of the machine also decreased, while the action between the circuits is not detrimental, as in the old form of double-winding. Owing to the smaller quantity of copper wire required, the number of crossings on the heads is reduced.

In practice, the brushes of the exterior circuit may be kept in a constant position, and the field brushes moved through almost ninety degrees in regulating, with no spark at either commutator; or both brushes may be kept constant under a variable load, regulation with the field brushes being only necessary with variable, speed as in water-power installations.

These are all claims that cannot be fulfilled with the old form of machine with double copper-windings.

Some of my dynamos have been in use more than two years, and the results have been so remarkable that I have no intention of abandoning my invention, while, had it been the same as that of Mr. La Roche, I would probably have followed his example in that respect before this.

C. F. WINKLER.

TROY, N. Y., July 9, 1891.

Reports of Companies.

THE WESTINGHOUSE SITUATION.

Before the close of business on July 7, 131,096 shares of Westinghouse Electric stock had been deposited under the reorganization plan. This left only 4904 shares outstanding. The books closed that day, and the reorganizers have reserved the option of refusing further tenders of stock.

NORTH AMERICAN PHONOGRAPH CO.

The schedules of Jesse H. Lippincott, president of the North American Phonograph Company and sole licensee of the American Graphophone Company, have been filed in the Court of Common Pleas. They show liabilities of $1,191,050.47, nominal assets of $3,471,938.58, and actual assets of $168,950.92.

THE EDISON GENERAL ELECTRIC CO. has declared its seventh quarterly dividend of 2 per cent., payable August 1.

Society and Club Notes.

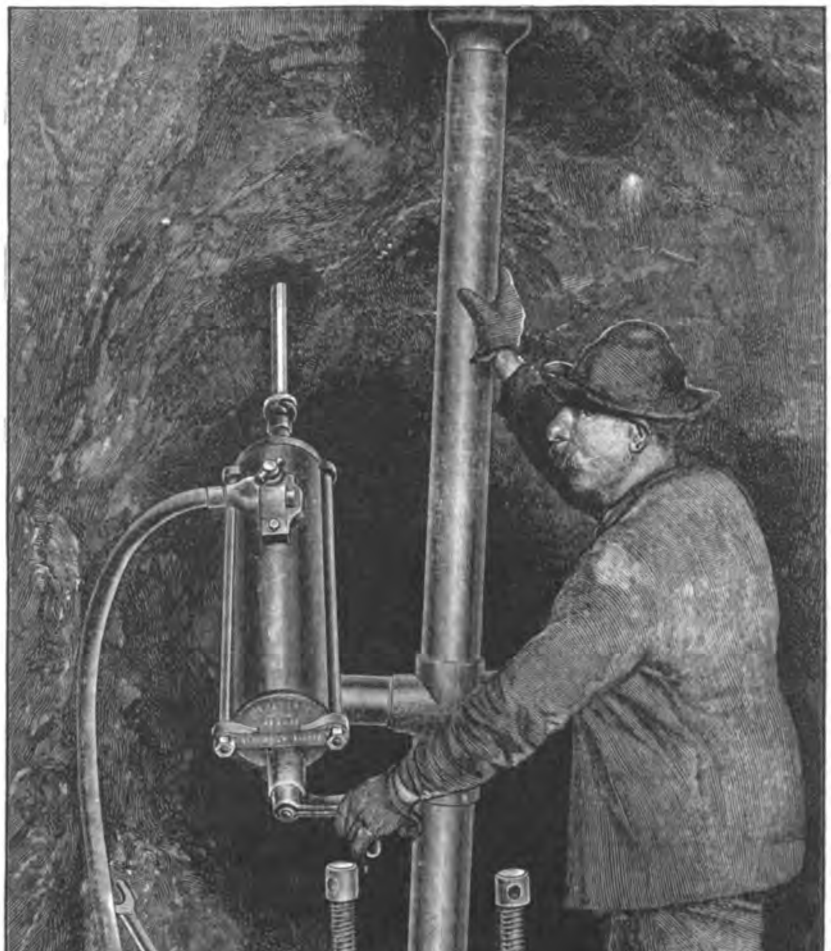
NEW YORK ELECTRICAL SOCIETY.

By invitation of the Palisades Amusement Co., extended through its consulting electrical engineer, Mr. W. J. Hammer, the New York Electrical Society was enabled last Friday to hold its annual meeting at the beautiful new resort "El Dorado," on the Hudson River heights of Weehawken. The business meeting was held at 8.15 p. m., when Treasurer Sinclair and Secretary Guy made highly satisfactory reports, showing the society to have a handsome balance and a total of 264 members. Prof. F. B. Crocker, who was in the chair, was re-elected president, Mr. H. A. Sinclair, who has so long been treasurer was re-elected, and the same honor, as secretary, fell to Mr. G. H. Guy, whose very intelligent work was acknowledged by a special vote of thanks. With these gentlemen were associated in the management for 1891-2 Messrs. E. L. Bradley, Chas. Steinmetz, T. C. Martin, W. J. Hammer, F. J. Sprague and G. H. Stockbridge. After a little other routine business the members and their friends to the number of about 200 adjourned to the amphitheatre to witness the great spectacle of the building and overthrow of Solomon's Temple. This done, they went under the escort of Mr. Hammer and Messrs. Radford and Martin, of the Thomson-Houston Co., to inspect the very neat and efficient electric light plant that has been installed. This plant, which stands apart in a building of its own, consists of three Thomson-Houston arc dynamos of 58 lights each of 1,500 c. p. and one Thomson-Houston direct incandescent dynamo of 700 lights capacity of 16 c. p. These machines are run by two McIntosh-Seymour engines of corresponding horse power, with Underwood cotton leather belting. There are two 80 h. p. boilers, single return tubular, and a 65 foot smokestack. The whole steam equipment was installed by Pearce & Thomas. There are 150 arcs scattered about the grounds on three circuits. There are 628 of the incandescents in the grand stand, castle, restaurant, offices, orchestra, dressing-rooms under the stage, and other places. It is proposed to change the lamps to 10 c. p. There are some 50,000 gas jets about the grounds. These, proving very uncertain at such a breezy altitude, cause one to hope that the electric plant will soon be extended. The plant was put in for the Thomson-Houston Co. by Mr. F. A. Bowman, and the whole work was done under Mr. Hammer's supervision and consultation.

After inspecting the plant, seeing the fireworks, and listening to an admirable concert, the Society returned to New York, with its mind fully made up that El Dorado is a place for every New Yorker to visit at once and often.

ELECTRIC DRILLING IN THE "LAST CHANCE" MINE.

THE illustration on this page affords a good idea of the ease with which electricity is introduced into mines. It shows one of the Edison drills at work in the "Last Chance" mine, at Wardner, Idaho. Speaking of the operation of the plant, which supplants a pneumatic outfit, the engineer in charge of the mine says: "Operating two air drills for twenty-four hours required five cords of wood, while for running four electric percussion drills for the same length of time, each drill doing more work than the air drills, it requires only one and one-half cords of wood. The electric percussion drills have been found to do more work than the air drills, and in consequence the air drills have been replaced by electric drills. The air plant was situated 1,000 feet higher up the mountain than was required with the electric drill, and the fuel had to be carried to the air plant this increased distance over that necessary for the electric percussion drill." Testimony of this kind is hard to gainsay, and is more than substantiated by the reports from other electric mining plants.



EDISON ELECTRIC DRILL IN THE "LAST CHANCE" MINE.

ELECTRICITY AND MINE VENTILATION.

In a communication appearing in the last issue of the *Coal Trade Journal* Mr. P. P. Quackenboss advances a novel theory to account for explosions in coal mines, which is of special interest, as the investigation was undertaken to controvert the opinion expressed by some mining engineers that the employment of electricity in coal mines was attended with danger on account of the liability to explosion due to a possible spark.

Mr. Quackenboss' investigations had led him to the conclusion that the forcing of hundreds of thousands of cubic feet of air into an air shaft to eliminate a few hundred feet of gas was a waste of power. Then, again, it was being constantly polluted by mephitic gases during its journey through a mine from the natural exudation of "blowers" and "blasting." Then carbureted hydrogen as it makes its first appearance in a mine is a *dry* gas and is expansive and inflammable, but if it finds an excess of hydrogen present it becomes a *saturated* gas and explosive. Thus, we have density and humidity and hydrogen in a finely subdivided state, and it only needs a little agitation of the air and gas to prepare a big or little pyrotechnic display.

The ordinary condition of a mine did not seem to present the excess of hydrogen spoken of above, so Mr. Quackenboss sought for it in the air forced into the mine by the fan at the mouth; he then saw at once that barometric change would produce the result if other conditions were right, and so taking a list of mine explosions to Sergeant Dunn, the Signal Service officer at New York, and explaining his theory, they took the record of temperature issued by the War Department, and selecting four cases, as follows, were surprised at the record.

January 23rd, 1889, at Wilkes Barre, explosion of mine gas. At that time the record shows a high pressure just passing off and a low pressure just approaching from the W. S. W.; barometer 30.10. April 15th, 1889, at Wilkes Barre, explosion and *precisely* the same conditions. January 18th, 1890, at Avondale, exactly the same conditions and result. June, 1890, the Hill Farm explosion at Dunbar, exactly the same conditions and result. They then started again with a list commencing with an explosion at Rich Hill, Missouri, March 23, 1888, and again the high pressure was receding and low pressure approaching; barometer 30.10 to 30.20. In all the cases from then down to January 1st, 1891, the conditions were identical, and in each case the humidity was increasing so as to be marked plus.

As a result of these investigations Mr. Quackenboss concludes that the mine ventilation of the future must be done by exhausting the foul air from the mines instead of the method now in vogue, in which the air is forced in from the outside. This will remove the final objection raised by some to the use of electricity in coal mines.

ELECTRICAL UTILIZATION OF WATER-POWER IN EUROPE.

It is expected, writes our London correspondent, that a feasible scheme will be promulgated for utilizing the countless tons of falling water in the Alpine district. A continental paper says that there are twelve towns in Switzerland erecting installations, and this activity is seen elsewhere, for in Austria an engineer proposes driving a train line electrically, as well as supplying electric light to six villages. In the Harz a syndicate is about to build an embankment across the Bodethal, and thus alleviate the inundations, at the same time utilizing the water-power for lighting the adjacent towns, Thale, Quedlinburg, and Blankenburg. The cost is estimated at 2,000,000 marks. At Lagenthal, in Switzerland, 3,000 h. p. are being obtained from the Aar for a light and power installation.

A very curious electric company has been formed at the village Faide, on the Gotthard railway, a place numbering 1,000 inhabitants. It obtains from the torrent Pinmogna a small supply of water (35 litres per second) by means of an iron pipe, which drives below a small high-pressure turbine, which, with a pressure of water of 145 metres, evolves 45 h. p. The turbine drives a dynamo which supplies the little village with 360 glow lamps. The whole cost 40,000 francs. In this manner, in addition to the streets and the railway station, the peasants and workingmen have their houses supplied very cheaply with the electric light, which is elsewhere regarded as a luxury.

FOUR murderers and one horse were executed by electricity at Sing Sing last week. The thing was done in secret, in accordance with the law which established electrical execution in New York, but the current appears to have been turned on each prisoner more than once. The crime of the horse is not stated.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JUNE 30, 1891

Alarms and Signals:—

Hotel Indicator, F. B. Wood, 454,924. Filed Aug. 2, 1890.
A recording or indicating system; including means for signaling from the office of a hotel, or from a main station, to rooms or sub-stations, to indicate fire or for other purposes.

Electric Signaling Apparatus, M. Martin, 454,973. Filed Nov. 5, 1888.
Especially applicable to fire-alarm service, but applicable for other purposes. May be operated automatically or by hand.

Circuit for Electric Signaling, M. Martin, 454,974. Filed Nov. 5, 1888.
Particularly applicable to fire-alarms.

Circuit Closer for Burglar Alarms, D. A. Palmer, 455,005. Filed May 26, 1890.

Electrical Annunciator, W. F. Harte and C. A. Gerold, 455,016. Filed Mar. 28, 1891.
Especially adapted for hotel use and provides means for calling guests at previously designated times.

Push-Button, G. W. Wright, 455,086. Filed Apr. 10, 1891.

Electric Signal for Steam Vessels, D. D. Wass, 455,138. Filed Jan. 5, 1891.
For communication between the pilots and the engineers of steamers; provides means for indicating by sight as well as by sound.

Clocks:—

Electric Clock for use in Electric-Lighting and other Systems, F. von Hefner-Alteneck, 455,041. Filed Feb. 25, 1891.
Relates to the regulation of time-pieces which are inserted in electric lighting circuits or other systems of distribution. Shown as adapted to parallel distribution.

Electric Time-Denoting Device, W. Ramsay, 455,055. Filed Jan. 15, 1891.
Relates to operating and controlling a series of time-pieces from a main clock by electrical means.

Conductors, Conduits and Insulators:—

Method of Laying Electric Conduits, A. C. Chenoweth, 454,988. Filed June 30, 1887.
Forms a continuous conduit by preparing a centering, of the required shape and size, by spirally-winding a core with strips of the material of which the centering is made, withdrawing the core, and surrounding the centering with the material of the conduit in a plastic condition, and withdrawing the spiral centering after the plastic material has hardened.

Means for Constructing Electric Conduits, A. C. Chenoweth, 454,989. Filed Mar. 7, 1891.
Similar to the next above.

Dynamos and Motors:—

Electro-Dynamic Machine, G. J. Scott, 454,882. Filed Jan. 2, 1891.
Adapted to be used either as a motor or as a generator for either continuous or alternating currents.

Motor Generator or Transformer, G. J. Scott, 454,883. Filed Jan. 14, 1891.
An electric generator adapted to serve also as a motor, or, a primary and secondary circuit being provided, to serve as a transformer.

Electro-Magnetic Motor, N. Tesla, 455,067. Filed Jan. 27, 1891.
An improvement primarily designed for application to alternating-current motors of the type invented by Mr. Tesla. Employs a condenser or condensers in the armature to neutralize its self-induction. Provides an armature core, the plates or laminations of which serve as opposite plates or armatures of a condenser.

Electric Motor, F. L. McGahan, 455,109. Filed Feb. 11, 1891.
Composed of a series of coils connected by commutators and brushes to wires of a main circuit, so mounted upon a shaft that the ends of the cores of the magnet coils may be successively brought into frictional contact with the inner periphery of the wheel to be driven.

Electric Motor, F. L. McGahan, 455,110. Filed Feb. 16, 1891.
Similar to the next above. The inner periphery of the wheel to be driven has a corrugated surface which is engaged by corresponding projections upon the ends of the revolving magnet core.

Automatic Regulator for Electric motors or Dynamo-Electric Machines, S. S. Wheeler, 455,267. Filed Nov. 8, 1890.
Employs the method of shifting the position of the commutator brushes, but reduces the sparking effects generally encountered in that mode of automatic regulation by greatly increasing the magnetizing effect of the armature coils relatively to that of the field coils—making the armature magnetism and that of the field magnets nearly equal, instead of making the latter so strong as nearly to overpower the former.

Lamps and Appurtenances:—

Carbon for Electric-Arc Lamps, W. H. Lawrence, 454,873. Field April 9, 1887.
The carbon rod has a compressed seamless spheroidal end. Designed to form better points.

Electric Incandescent Lamp, N. Tesla, 455,069. Filed May 14, 1891.
Two conducting bodies, mounted in a very highly exhausted receiver, are rendered incandescent when connected directly or inductively to the terminals of a source of current of very high potential and very great frequency.

Clutch for Arc Lamps, F. H. Thompson, 455,071. Filed Oct. 18, 1890.

Electric Arc Lamp, C. R. Arnold, 455,087. Filed May 23, 1890.
Relates particularly to an adjustable arrangement of the support for the lower carbon; designed to permit the use of carbons of irregular lengths.

Filament for Incandescent Electric Lamps, G. Erlwein, 455,187. Filed Feb. 18, 1891.
Consists in providing filaments with a solid coating which will not melt at incandescent temperature, protecting the core from atomization. Employs a coating of nitrides of boron.

Socket for Incandescent Electric Lamps, B. B. Keyes, 455,297. Filed Oct. 6, 1890.

Measurement:—

Electric Meter, H. M. Pilkington and R. S. White, 454,949. Filed Sept. 26, 1890.
Relates to the class of meters in which the registering apparatus is driven by a separate source of motion and controlled by the variations of the current passing.

Electrical Meter, N. Tesla, 455,068. Filed March 27, 1891.
Maintains, by the current to be measured, a potential difference between two conductors in an electrolytic solution, uniform throughout the length of conductors exposed to the solution, and computes the energy expended in a given time by measuring the variation of the resistance of one or both conductors due to the gain or loss of metal by electrolysis.

Metal Working:—

Electric Soldering Iron, A. E. Appleyard, 455,010. Filed Oct. 1, 1890.
Has a conducting loop of platinum wire or other like material placed within the soldering head.

Miscellaneous:—

Apparatus for Removing Inductive Effects from Electric Lines, E. Thomson, 454,890. Filed April 8, 1889.
Especially applicable to neutralizing the effect on telephone lines of induction from parallel electric lighting lines. Consists, essentially, in setting up a counter-acting field of induction, operating upon two or more telephone lines, each of which latter is arranged in a different portion of the field of counter induction, so as not to induce upon each other.

Time-Lock, G. W. Adams, 454,897. Filed Feb. 9, 1891.

Aerial Cut-Out, J. R. Fletcher, 454,904. Filed Sept. 30, 1890.
A fuse cut-out for aerial conductors.

Protector for Use in Electric Circuits, W. H. Clausen, 454,926. Filed Dec. 22, 1890.
A device for diverting dangerously strong currents from telephonic, telegraphic and other apparatus by automatic means.

Phonograph Recorder or Reproducer, T. A. Edison, 454,941. Filed May 24, 1890.
Diaphragm is made thickest at its centre and thinnest at its periphery.

Phonograph, T. A. Edison, 454,942. Filed July 30, 1890.

Reproducer for Phonographs, W. McMahon, 454,947. Filed Nov. 19, 1890.
Employs a resonant box having an attached stylus.

Electric Current Regulator or Rheostat, C. D. Sigsbee, T. S. Hayward and F. S. Anderson, 454,969. Filed March 10, 1891.
Especially adapted to regulation of incandescent lamps, but may be used for other purposes requiring adjustable resistances. The resistances are composed of relatively long elastic fibres coated with a conducting substance.

Electric Heater, C. W. Drew and E. R. Francis, 454,979. Filed Feb. 20, 1890.
Employs an electric heating resistance arranged within a casing which also contains an adjustable rheostat; a switch is provided for cutting in or out the rheostat coils.

Electric Temperature Controller, E. H. Parker, 454,985. Filed Dec. 24, 1890.

Electric Switch, J. Des Brisay, 454,995. Filed Dec. 10, 1890.
A two-pole switch adapted especially for use on lighting circuits.

Apparatus for Boring Wells, F. Gardner, 455,037. Filed Sept. 1, 1890.
Employs an electric motor for operating the boring tool; the motor being of a diameter adapted to enter the bore of the well and to follow up the tool.

Automatic Electric Switch, C. O. C. Billberg and P. A. N. Winand, 455,099. Filed Nov. 11, 1890.
A time-switch, to be operated by hand or by means independent of the circuit to be controlled; applicable to the gradual throwing on or off of current serving an electric motor.

Appliance for Playing Games of Chance, A. Harris, 455,100. Filed Feb. 19, 1890.
Includes an electro-mechanical indicator.

Electric Post-Office Box, W. A. M. and R. T. F. Smith, 455,126. Filed March 4, 1891.
Employs an electro-magnetic door-releasing device.

Apparatus for Automatically Regulating the Firing of Ordnance on Ships, M. J. Cuadros, 455,176. Filed Aug. 27, 1890.
A contact device, depending upon the action of a pendulum, is employed to discharge a gun automatically when the ship, which may be rolling or otherwise moving, reaches the normal position.

Lightning Arrester, F. Mansfield and C. W. Mason, 455,223. Filed July 22, 1890.
Employs a series of safety-strips upon which a gravity lever makes contact successively.

Telethermometer, F. W. Wiesebrock, 455,268. Filed Aug. 9, 1890.

Railways and Appliances:—

Overhead Electric-Conductor System, G. J. Scott, 454,881. Filed Dec. 10, 1890.
A contact device intended to supersede the ordinary trolley and pole. Employs a long multiple-contact device adapted to hang from the top of the wire and to travel upon it, being drawn along after the car in any suitable manner.

Electric Car-Motor Jacket, J. Stephenson, 454,888. Filed Dec. 12, 1890.
A housing to protect the motor from mud and dust.

Method for Connecting Trolley and Feed Wires, J. R. Fletcher, 454,908. Filed Sept. 30, 1890.

Circuit-Connection for Electric Car Motors, A. A. Ingraham, 455,019. Filed Nov. 18, 1889.
Arrangement of circuits and switching apparatus adapted for storage-battery cars.

Insulator, J. F. Munsie, 455,107. Filed Mar. 28, 1890.
For electric railway conductors. Special provision made for excluding moisture.

Electric Railway, J. F. Munsie, 455,233. Filed May 8, 1891.
Employs an underground feeding conductor, a series of branch conductors therefrom separated by intervening spaces, overhead contacts normally out of connection with the branch conductors, and a bar mounted upon the car and in the motor circuit, the bar adapted to bring the overhead contacts successively into connection with the branch conductors.

Electric Railway, J. F. Munsie, 455,234. Filed May 8, 1891.
In connection with a feeding conductor employs a trolley track consisting of a series of sections suspended in an upright position and adapted to swing downwardly.

Electric Railway Signal, W. Stevens and H. J. Hovey, 455,296. Filed Nov. 11, 1890.
Automatic apparatus in which moving trains act upon circuit-controlling devices to alter the position of the signals to block and clear successive sections of the track.

Telegraphs:—

Electrical Transmission of Telegraphic and Time Indications, H. J. Haight, 454,867. Filed Mar. 27, 1889.
Amplification of the invention shown in the same inventor's patent of Dec. 16, 1890, No. 442,880; adds means for transmitting telegraph signals, time signals and meteorological indications.

Printing Telegraph Instrument, F. Sedgwick, 454,884. Filed June 1, 1886.
A printing telegraph machine or electric typewriter, operated by a rotary motor and the usual key-board; may be used singly as a typewriter or connected with one or more similar machines, all of which may be operated synchronously by the manipulation of any one of them or by that of a machine common to all.

Printing Telegraph, H. Van Hoevenbergh, 455,075. Filed Feb. 24, 1891.
Relates to the class of printing telegraphs in which the type-wheel is controlled by a segment contact wheel.

Printing Telegraph, D. H. Bates and H. Van Hoevenbergh, 455,291. Filed Mar. 4, 1891.
Employs two similar type-wheels on the same machine, serving to print messages in duplicate.

ALERNATING CURRENT LITIGATION.

A suit was commenced on July 2, in the U. S. Circuit Court of the district of Vermont, by the Westinghouse Electric and Manufacturing Co. against the Marble City Electric Light Company of Rutland, Vt., alleging an infringement of the patent of Rankin Kennedy, reissue No. 11,031 of September 4, 1889, for a system of electrical distribution. The real defendant in the case is the National Electric Manufacturing Co. of Eau Clair, Wis., which was the constructor of the Rutland plant. The system of distribution covered by this patent is that of operating transformers in multiple arc by alternating currents, in order to effect automatic regulation, and is an essential feature of all the alternating systems now in use. The Kennedy patent was purchased by the Westinghouse Company some years since, and is claimed to cover the fundamental invention embodying this principle.

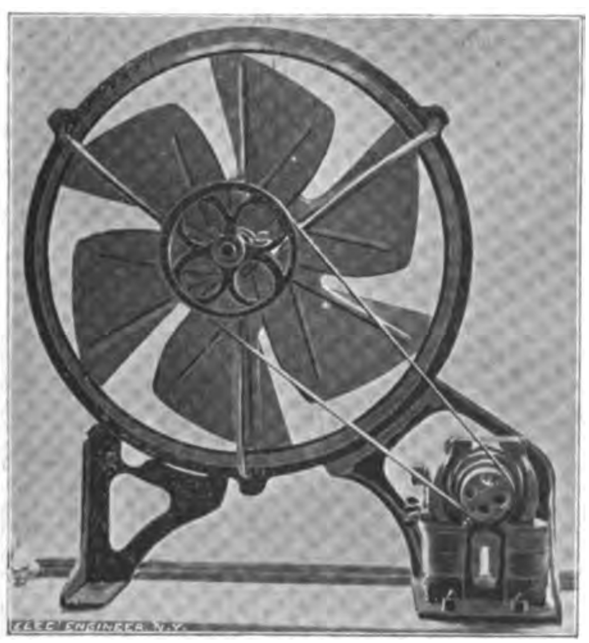
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

An "ad" can be effective without being either saucy, or loud, or vulgar.

THE LA RUE ELECTRIC FAN OUTFIT.

THE accompanying illustration represents an electric fan combination manufactured by the Crocker-Wheeler Motor Co., of this city, for the ventilation of large rooms, halls, etc. The distinguishing feature of this combination is the relative position of the motor in regard to the fan. It has been found that, when the motor is placed at the centre of the fan, a very appreciable



LA RUE ELECTRIC FAN OUTFIT.

amount of breeze is cut off, and just so much power wasted, whereas this arrangement leaves the current of air practically uninterrupted.

The engraving shows a $\frac{1}{4}$ h. p. Crocker-Wheeler motor and 24 inch fan on one base, and known as the "La Rue Combination." Both fan and motor have self-oiling bearings, and the speed can be instantly changed from fast to slow, or vice versa, by means of a switch. The maximum speed of the fan is 600 revolutions per minute and the pulley is double flanged to prevent slipping of the belt. This combination is a very serviceable one, and has called forth many commendations.

GAYNOR ELECTRIC CO.

The Gaynor Electric Co., of Louisville, Ky., report that they are doing a large business in fire-alarm and police signal apparatus. They have just finished two large contracts for the installation of the central office fire-alarm system, one at San Antonio, Tex., and the other at Lincoln, Neb. Within the last week or ten days they have been awarded contracts for their fire-alarm system in Clinton, Ia., Rome, Ga., and Danville, Ill. Their new factory is now completed and they are moving into it. It will be the largest factory in the South for the manufacture of electrical apparatus. They will occupy the entire three floors of the building, 120 feet long and 60 feet wide. This factory is situated on the Belt line railroad, giving them excellent receiving and shipping facilities. They also have yard room of about one acre. Mr. J. H. Sutcliffe is president of the company; J. J. Barrett, vice-president, and T. F. Gaynor, superintendent.

MR. THOMAS G. SMITH, JR., M. E.

Mr. Thomas G. Smith, Jr., M. E., late member of the firm of C. R Vincent & Co., this city, has opened an office at No. 11 Hammond Building, Cincinnati, O., where he will continue the business of consulting and contracting engineer for the complete installation of steam plants for electrical and other purposes. Mr. Smith will represent the interests of the Ball & Wood Co., and will be the sole agent in that section for the sale of the Improved Ball Automatic Engine, which has acquired such an excellent reputation in electric lighting and railway work.

Mr. Smith has had an extended experience in the installation of all the best modern types of engines and will be prepared to furnish plans and specifications with special reference to the attainment of the highest economy in steam consumption.

JENNEY ELECTRIC MOTOR CO.

The catalogue recently issued by the Jenney Electric Motor Co., of 218 to 224 South Illinois street, Indianapolis, Ind., is an excellent piece of trade and technical literature. It is tastefully prepared, and everything is said to the point and with a purpose. Some of the quotations as to the value of electric power are very pertinent, especially that in which the Indianapolis *News* tells of the satisfactory work done by the 20 h. p. Jenney motor in its press room. The pamphlet, besides its general discussion of the subject, contains a full and interesting description of the motor and the various attachments, and shows sizes up to 50 h. p. A view is also given of a motor and pump outfit for hydraulic passenger elevator service, such as is now used in the Indianapolis Board of Trade Building. Following this come a number of pithy testimonials, and a short section devoted to data for power-users.

QUEEN & CO.'S TACHOMETERS.

Queen & Co., Philadelphia, are just now making a specialty of tachometers for indicating the speed of engines, dynamos, and motors. These instruments are quite as essential to the economical operation of a plant as ammeters and voltmeters, an appreciation of which fact is being demonstrated by the greatly increasing demand for them. By means of a tachometer it is possible to tell at a glance the exact rate of speed at which an engine or dynamo is running. For portable work a special instrument is made, which takes up but little space and can easily be carried about. This tachometer is as accurate in its readings as the larger type, mounted on a strong base and designed for permanent attachment in the engine or dynamo room.

BURTON ELECTRIC HEATER.

Mr. W. R. B. Willcox, who has charge of the electric heating department of the Electric Merchandise Co., of Chicago, has recently been in the East looking over the field and conferring with Mr. S. Dana Greene, the electrician of the Burton Electric Heater Co. This trip was rendered necessary by the large number of inquiries received not only from electric street railroads but also from a number of the leading steam roads that are using electricity for lighting purposes on some of their trains and are anxious to adopt the heater in place of other means of warming their electric-lighted cars.

WIRT INSULATING JOINT.

The Electrical Supply Co., of Chicago, have recently brought out the Wirt insulating joint. It is very simple, and has no loose parts or screws. It is guaranteed to be strong and absolutely gas and "electricity tight." It is only $\frac{3}{8}$ in. by $\frac{3}{8}$ in. and is listed at a low price.

THE SIOUX CITY ENGINE WORKS.

The Sioux City Engine Works report business as improving very greatly the past few weeks. They have steadily had work since January 1st, on the popular selling sizes of their standard Corliss and Giddings' automatic, and have a large number of engines finished and ready for prompt delivery. The prospects for the season's business were never before better at this time of the year. The applications for estimates and prices are largely for the largest size engines and steam plants They are now completing some special machinery which will greatly increase their facilities for both quantity and quality of work, and are also running and expect to run for the next six months a large night and day force in order to keep up with the demands of the trade.

Among the recent orders taken are two 22x36 compound condensing engines sold to W. J. Hobson for his electric lighting and railway plant now being built at Waco, Texas; one 14x36 to Morton, Lawshe, Savannah, Mo.; one 9x14 to the Sioux Refrigerator Co., of Sioux City, Ia., for electric lighting and to drive the elevators; a 9x14 to James F. Toy, of Sioux City for electric lighting; a 16x36 to M. P. Bewley, of Fort Worth, Texas; two 18x42 and one 12x36 Standard Corliss to the Moline Plow Co., Moline, Ill., and a 100 h. p. Corliss to the Illinois Chair Manufacturing Co., of Rockford, Ill. Negotiations are now pending for several other large plants, contracts for which will be closed within a few days.

Among the recent shipments was a 14x36 to the Fremont Milling Co., Fremont, Neb.; a 16x42 to the Crane Manufacturing Co., Chicago, and an 18x36 to the Northwestern Sewer Pipe & Tile Co., of Sioux City, including boilers and complete steam plant; one 11x24 Corliss to James Thorndyke & Son, Randolph, Neb.; 12x24 Corliss to the Menno Milling Co., Menno, S. D.; and one 14x36 Corliss to Fletcher & Case, of Sioux City, for their planing mill.

It is evident that these engines are rapidly winning their way into public favor; this has been done on the merits of the sample plants put in during the past two years. Reports from electric railway contractors indicate that they have found no better and closer regulating engines than the Sioux City Corliss.

THE BAXTER ELECTRIC MOTOR CO.'S QUICK WORK.

On the 8th of June the Baxter Electric Motor Co., of Baltimore, shipped three trucks with motors attached to Beatrice, Neb., and on the 12th they sent a generator of 80 h. p. At the same time an expert electrician was despatched from the works to put the road in operation, including the erection of the power house. The following telegram has since been received by the company: "Second car started June 27th, 11:30 P. M., 2,500 passengers Sunday, without a hitch of any kind."

The company have a large number of orders for cars and motors throughout the South and West, and are shipping the goods just as fast as they are finished. The company's electric motor cars are now running in Richmond on the Richmond and Manchester Street Railway; Dayton and Cleveland, O.; Chicago, Ills.; Washington, D. C., and many other places.

NEW EDITION OF THE OSTRANDER CATALOGUE.

W. R. Ostrander & Co., of 195–197 Fulton street, New York, and 1461–1463 DeKalb avenue, Brooklyn, have just issued the eighth edition of their Revised Catalogue. It now runs considerably over 100 pages, and includes a greater variety of appliances and apparatus than ever. All the familiar Ostrander specialties are shown, with many new applications and improvements. The catalogue ranges through tubes, push-buttons, bells, batteries, annunciators, gongs, letter boxes, whistles, etc., and shows an excellent choice of goods in every branch.

"NEVER FOUND ANY FAULT." "RELIABLE."

A. H. Baird, M. D.; writes from Jackson, Mich., April 7th, 1891, as follows: "Messrs.—Some twelve years ago I purchased one of the Jerome Kidder Electric Medical apparatus. Have never found any fault with the Battery, and always considered it a good one. The zincs are considerably worn but the rest, case and all, are practically as good as new."

E. C. Pence, M. D., writes from St. Louis, Mo., March 6, 1891: "Jerome Kidder Manufacturing Co., 820 Broadway, New York, Dear Sirs: We have been practicing with your electrical machines over twenty-five years, and when we want anything reliable always send to you. Enclosed please find Post Office order for—"

The Sun Arc Lamp Company, leased by the Great Western Electric Supply Company, Chicago, report unusually fine business for the past month. This company is manufacturing a lamp, which for simplicity, durability and excellence of construction is not excelled, it is claimed, by any other lamp in the market. We might add that it is sold for less money than any other arc lamp, good, bad or indifferent.

MOSHER ARC LAMPS FOR INCANDESCENT CIRCUITS.

The Mosher Arc Lamp Co. are in receipt of a number of testimonials as to the merits of their lamp. One of the most recent of these letters is subjoined:

BENICIA ELECTRIC LIGHT AND MOTOR CO.,
BENICIA CAL., June 26, 1891.

MOSHER ARC LAMP CO., CHICAGO.

Gentlemen:—Yours of 11th inst. received. In reply we have to say the lamp gives satisfaction, and we are well pleased with it. Our superintendent says he has tried two or three other lamps of different makes; this one is the best of them all. He wants you to send another just like it to the Dixon Light and Water Co., Dixon, Cal., of which he is superintendent. Enclosed please find check $26.75, to balance account. Yours truly,

S. C. GRAY, *Pres't.*

EDISON GENERAL ELECTRIC CO.

The Edison General Electric Co. has just issued a new pamphlet on their small Edison slow-speed motors, which are now being introduced in large numbers on incandescent circuits. The motor, which was recently illustrated and described in these columns, is of excellent design and finish, taking but little current and answering admirably for a great variety of uses.

THE PERKINS LAMP.

Messrs. Claflin & Kimball, 105 Summer street, Boston, the agents for New England of the Perkins incandescent lamp, write us that they have recently received two lamps from one of their customers, that had run over 12,000 hours and were still good. The remark that came with the lamps was that lamps lasting as long as that must be a curiosity. The average life of lamps on that plant was also high, reaching 2,500 hours, an evidence of what can be accomplished with good lamps in careful hands.

NEW YORK NOTES.

TRUEX AND VAIL, Electrical Exchange Building, report that the following railroad companies and electric light stations have adopted their swinging ball lightning arrester since they have been handling it: The Ball Electric Light Co., of New New York; The Hamilton and Lindenwald Electric Railroad, Hamilton, O.; The Federal Street and Pleasant Valley Railroad, Allegheny, Pa.; The Edison Company, Paterson, N. J.; The Danville Gas, Electric Light, and Street Railway Company, Danville, Ill.; The Cincinnati Electric Light Company, Cincinnati, O.; Porter Rawlings, Helena, Ark., electric light station; The Canton Electric Light and Power Company, Canton, O.; The City of Ottawa, Ill., on their local plant; The Jenkintown Electric Light Company, Jenkintown, Pa.; Utica and Mohawk Railroad, Utica, N. Y.: The Lindell Railroad Co., St. Louis, Mo.; and the Edison Electric Light Company, at New Brunswick, N. J.

PHILADELPHIA NOTES.

THE GLADSTONE APARTMENT HOUSE, owned by W. G. Warden, has had a fine plant designed, put in and started by Mr. A. J. Martin, the superintendent of the West End Electric Co. The plant comprises two Thomson-Houston 400-lighters and one 800-lighter, run by a double Greene engine of 200 h. p., high pressure. The building is wired for 3,000 lights, and has the Interior Conduit system throughout, with 34 feeders and risers. There are special switches arranged to connect the machines and circuits and also to charge storage batteries, and there is also a very fine black-slate switchboard.

THE HEISLER ELECTRIC LIGHT CO. have consummated arrangements with the Interstate Complete Electric Construction Co., 809 S. Seventh St., St. Louis, Mo., as their general agents for the sale of their apparatus in the State of Missouri and adjacent territory. They have also made similar arrangements with Messrs. M. V. Smith & Son (The Belton Electric Co.), of Belton, Tex., for the exclusive sale of their apparatus for the State of Texas and portions of Mexico.

MR. CHARLES G. BLANDY, formerly of the Columbia Electric Co., St. Paul, has become associated with Mr. M. S. Shapleigh, also well known in electrical circles in this vicinity. They have opened an office and factory at 244 Arch street, where they will continue to act as agents for the Electrical Supply Co., of Ansonia, Conn., and will also manufacture some electrical novelties of their own invention.

MR. J. W. PARKER has just closed a second contract with the Allentown & Bethlehem Rapid Transit Co. for a 150 h. p. Ball railway engine. He has also sold a 150 h. p. compound condensing Ball engine to the Lebanon (Pa.) & Annville Street Railway Co., and a 40 h. p. Ball engine to the Luxury Tobacco Works, of this city.

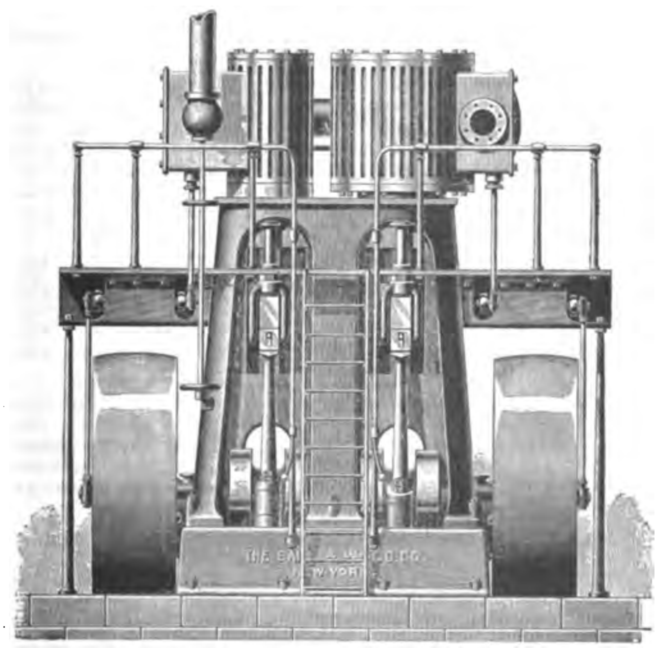
MR. M. S. SHAPLEIGH, dealer in electrical supplies, has removed from 112 So. 4th St., to more commodious quarters at 244 Arch street.

MR. H. L. LUFKIN of the C. & C. Electric Motor Co., has just returned from a trip to Colorado and Montana. His journey was so successful that he has brought orders for C. & C. motors for use in mining work, aggregating 200 h. p. or more. The motors ranging from 10 to 65 h. p., covering three separate installations.

BALL & WOOD HIGH-SPEED VERTICAL COMPOUND ENGINE.

A GLANCE at the comparative history of electricity and steam shows the interesting fact that, while the best form of slow-speed engine, the Corliss, was practically a perfected machine when the dynamo first came into commercial use, the high-speed engine may be said to have been developed simultaneously with the electrical industry.

The earlier dynamos were almost invariably driven by high-speed engines, not only because of the better regulation thus obtained, but because Corliss engines of small power were very expensive and cumbersome. Fuel economy in the small stations then in use was of less importance than compactness of plant and uniformity of speed.



BALL & WOOD HIGH-SPEED VERTICAL COMPOUND ENGINE.

As the business grew it was found that the relative economy of fuel between the two types of engines was about as twenty-seven is to thirty in favor of the Corliss engine, which figures represent the water consumption ordinarily obtained from each, per horse-power per hour. This advantage in economy was offset by the smaller cost of the high-speed engine, its less floor space, and the small cost of a reserved unit for emergencies, together with the better regulation obtained. To meet the popular demand for more efficient engines, compound cylinders were applied to high-speed engines with the most gratifying results.

It was found that compounding was specially adapted to this class of engines, and therefore a wider field for high-speed engines was opened. The scepticism at first expressed as to the desirability of non-condensing compounds was quickly answered by practical results.

The usual form for high-speed compounds is the horizontal, whether of the tandem or cross-compound type. In Europe the vertical form is extensively used, and it is believed by many that large high-speed, vertical compound engines will come into very general use here, particularly where floor space is valuable. The accompanying illustration shows a 500 h. p. engine of this class. The floor space required, including wheels, is about 8 ft. x 12 ft., thus giving over five h. p. per square foot of floor. The vertical height of this engine is about twelve feet above floor. This engine is built by the Ball & Wood Co. at their Elizabethport, N. J., shops, and has in its governor, valve, etc., all the characteristic features of the Ball engines.

For convenience of access, the front legs of the frame are arranged to be detached just below the gallery floor and removed entirely, thus allowing the shaft to be rolled out at the front of the engine. The rest of the frame is cast in one piece, except the guides, which are placed on finished seats in the frame. Both valves are driven from crank pins, instead of eccentrics, one being part of the automatic cut-off governor and the other set in a plate arranged for an adjustable cut-off.

The rock shafts are carried in adjustable boxes placed in a bracket, one end of which is attached to the frame and the other end supported by a pillar set on the foundation. This bracket is placed under the gallery floor and forms one of its supports at each side of the engine. A movable section of floor permits ready access to the rock shafts for inspection or oiling.

NEW APPLICATIONS OF THE CROWDUS CONSTANT PRIMARY BATTERY.

BY recent important and novel improvements made by Mr. Walter A. Crowdus the output of the primary battery has been so increased that quite a powerful and constant battery is made to occupy a very small space. An idea of this power is best obtained by a comparison with the well-known bluestone gravity cell. The Crowdus type of battery, 6 inches square, will, it is stated, develop a current equal to that of 200 bluestone cells, each 6 x 8 inches. Of course the total life of the 200 bluestone batteries would exceed considerably that of the Crowdus type; but the attention and handling demanded by the 200 batteries would be far in excess of the small one, doing the same work, hence the comparison has many points in favor of the new type. The Crowdus batteries are all made up in hard rubber cases, practically sealed, as far as handling is concerned, and are portable, there being no glass or loose porous cups in them. We have had occasion to illustrate these small batteries as they are now made up in hand and vase lamps. In this shape they are no larger than a coal oil lamp, and give greater light.

We illustrate this week another design and application of this battery. The engraving shows a small, square table with a 7-inch square battery placed upon the shelf beneath, with wire leading up to a portable or drop light placed upon the table. This outfit will give a 16 c. p. light for one evening, on one charge, at a cost of 1½ c. to 2c. an hour.

One very practical feature of this battery is that no electrical connections have to be studied out or attended to, and the only metal parts exposed are the two terminal knobs, which serve the

CROWDUS BATTERY WITH LAMP.

double purpose of handles for transporting the battery and electrical terminals.

The fan outfits are finding ready sale, even in offices located in the centre of electric power districts.

The Crowdus Chemical-Electric Co., Memphis, Tenn., owners of, and manufacturers under, Mr. Crowdus' patents, are also adapting these batteries to train lighting, and have a passenger train running regularly fully equipped with electric light, including head-light, supplied from their battery, the light being much brighter than was obtained from the oil lamps. Concerning this, however, we shall have more to say, as it is a departure of much importance.

WESTERN TRADE NOTES.

THE POND ENGINEERING CO. has recently received a large order for the well-known Armington & Sims engine, for which they are the general Western agents. This order is from the Chicago Edison Co., and the engines, of 400 h. p. each, will go in the central lighting station on Adams street. The first engines in this plant were made by the Armington & Sims Co., but the management thought best to make a trial of other makes. After careful tests they have ordered as above. They were anxious, it is stated, to place their entire order for their new equipment with the Armington & Sims Co., but the latter, owing to other large orders, were unable to promise delivery as required. The Edison Co., therefore, gave them orders for as many engines as they could furnish, and placed the contract for the rest of the equipment elsewhere.

POINTS ON LIGHTING.—At a recent meeting of the Illinois Chapter of the American Institute of Architecture, Mr. Thos. G. Grier read an excellent paper on incandescent electric lighting. After a clear statement of the elementary principles of electrical science employed in lighting, an interesting description was given of the various systems used in ordinary interior wiring. Mr. Grier also called attention to the importance of the assistance of the thoroughly trained electrical engineer to the architect, and urged the necessity of such expenditure in electrical work as would secure competent supervision and the use of good material.

THE CENTRAL ELECTRIC COMPANY are showing some very handsome samples of lead-encased Okonite cable. The demand for this class of cable has increased so lately that the Okonite Company have decided to go into its manufacture on a large scale, and are selling their product in the West through the above company, who are their general Western agents. They have already received some flattering contracts and will soon be in the field as active competitors for this class of work. They are also prepared to lay the cable, and deliver it connected up, ready for current, having especially good facilities for performing these contracts.

THE GREAT WESTERN ELECTRIC SUPPLY CO., Chicago, have leased spacious rooms at Nos. 193, 195, 197, and 199 South Canal street, where they contemplate moving about August 1st. In these greatly enlarged quarters they propose extending their manufacturing facilities, and we wish them the success which they well merit. This house carries one of the largest line of supplies in the United States and is progressive, energetic, and above all straightforward in its treatment of its many customers, scattered throughout every section of the country.

ELECTRICAL SUPPLY CO.—Upon calling on the Electrical Supply Co. at their new quarters, 102 and 104 Michigan avenue, one is confronted by tons and tons of articles electrical piled in chaotic masses—but behind it all beam the cheerful faces of Mr. Terry and his several managers. They don't seem "flustered" by the dismal disorder—but are all hustling things into place and shape. They will have one of the most complete establishments in existence when finished.

THE ELECTRIC MERCHANDISE CO., of Chicago, has received the entire order for the overhead electrical equipment of the electric street railway at Memphis, Tenn., as well as the rail bonds and poles. As it was necessary for all such material to have the approval of the company supplying the electrical plant, the Electric Merchandise Co. looks upon this very naturally as the strongest kind of endorsement of the line material of their manufacture.

THE NORTHWESTERN ELECTRICAL SPECIALTY CO. are meeting with great success in the sale of the Economic incandescent lamps, which they handle in the West. Mr. Kirkham, manager of the company, reports his sales as increasing rapidly, and says that the lamps are giving good satisfaction in the many places in which they have already been used.

MR. E. R. GILMAN, president of the Great Western Supply Co., sailed, July 8th, on the "City of New York," for a trip to Europe. He will make a tour through Scotland, Ireland, France and Germany, and will probably be gone a couple of months. Mr. Gilman, before sailing, closed contracts aggregating $100,000.

THE ILLINOIS ELECTRICAL MATERIAL CO. are doing quite a large business in electric street railway supplies, all kinds of which they handle, and also in the exclusive specialties for this work, which they control. They have recently closed contracts for the equipment and line material of several new railway plants.

MR. J. H. COOKE, secretary and treasurer of the Sunbeam Incandescent Lamp Co., of Chicago, has returned from a recent trip to New York, Boston and Philadelphia, from all of which cities he brought away valuable souvenirs in the shape of voluminous orders for Sunbeams.

MR. LEM. S. BOGGS, graduate of the mechanical department and also of the electrical department of Purdue University, Lafayette, Indiana, is in Chicago, where he proposes to locate and will probably enter the field of electrical mining.

CUTTER'S MINE SWITCHES.—Mr. George Cutter has developed some waterproof switches and cut-outs for use in mines and tunnels, and a number of these are already doing good service. The presence of excessive dampness and in some cases of running water renders the ordinary devices useless, and the good features of Cutter's mine switches and cut-outs will probably do much towards the extensive use of electricity in mines. Mr. Cutter is also working out some novel switchboard fittings and has just completed a slate-base theatre switchboard, which is as neat as it is serviceable.

MR. C. T. PAGE, manager of the Englewood Electric Light Company, sailed for Europe on the 11th inst. The Englewood Electric Light Co. have made Kohler Bros. & Grier, of 341 Rookery Building, their authorized agent and contractors for all inside wiring in their territory. Mr. Thomas G. Grier will have general supervision of the work. Mr. J. H. Stahley, formerly a construction superintendent for the North American Construction Co., will be in direct charge for Kohler Bros. & Grier.

THE GREAT WESTERN ELECTRIC SUPPLY CO. were awarded the contract for supplying the steel poles to be used on the extensions of the Citizens' Street Railway Co., of Indianapolis, Ind. The demand for their new steel pole for electric railways is very brisk, and numerous inquiries are received daily from all parts of the country. The pole is very remarkable for its strength and beauty. They have just issued a tastefully illustrated circular regarding its merits.

THE LINCOLN, ILL., ELECTRIC RAILWAY, of Lincoln, Ill., have contracted with the U. S. Railway Equipment and Construction Company, for a complete Westinghouse street railway plant, comprising one 80 h. p. generator, three motor car equipments having two 20 h. p. motors on each car. Four and a half miles of road will be immediately constructed.

MR. GEORGE CUTTER, the "Electrical Specialist," of the West, is doing a good business in his many valuable specialties for electric light, street railway and power plants. His new magnetic cut-out, which was recently illustrated in one of these columns, is finding a ready sale, on account of its excessive usefulness, simplicity and low cost.

MR. G. E. FISH has accepted an appointment as superintendent of electric lighting at Little Rock, Ark. He is a well-known electrician, having been for a long time superintendent of the Chicago Arc Light & Power Co., and well known to the electrical fraternity here, who will note with pleasure his new connection.

J. LANG & CO., who make the well and favorably known Andrews & Lang switches, are now, in addition to their direct-current switches, making a very fine line of alternate-current switches, which show the same excellent finish and workmanship for which their goods are noted.

MR. FREDERICK L. MERRILL, the recently appointed Chicago agent of the Jenney Electric Motor Co., has just installed a 1 h. p. machine for operating a 36-inch Andrews & Johnson exhaust fan, and reports the outlook for business with this excellent line of motors as very flattering.

MR. JEAN A. WETMORE, of the International Okonite Co., New York, was a Chicago visitor last week and a caller at the Western office of THE ELECTRICAL ENGINEER. Mr. Wetmore is talking Okonite as picturesquely and pertinently as ever.

MR. GEORGE H. MEEKER, the popular manager of the Chicago branch house of the New York Insulated Wire Co., 76, 80, 82 Franklin street, is shipping large quantities of the famous Grimshaw wires and cables to all parts of the West.

THE SUNBEAM INCANDESCENT LAMP CO., of Chicago, who recently shut down their factory for a time, making boiler and other necessary repairs, started again in full blast last week, and are once more turning out Sunbeams by the million.

THE JEWEL INCANDESCENT LAMP, in the hands of Mr. Wm. Hood, is selling very rapidly. Tests of the lamp have shown it to be very efficient and long lived, and they are giving satisfaction in all the plants where they are being used.

MR. CHARLES A. BROWN, the widely-known manager of the Western Electric Co., who has resigned that position to take up the practice of law, will be succeeded by Mr. C. D. Crandell, who will take hold immediately.

ANDREWS & JOHNSON, manufacturers of large fans for ventilating purposes, report business as prosperous, and they are turning out all the work they can handle.

MR. W. J. FLOYD, of the Sperry Electric Co., has gone East for a short trip.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

EXTRA—The Edison Lamp Decision.

THE

Electrical Engineer.

A WEEKLY REVIEW OF THEORETICAL AND APPLIED ELECTRICITY.

Vol. XII. Extra No. NEW YORK, TUESDAY, JULY 14, 1891. Price 10 Cents.

DECISION UPHOLDING THE EDISON LAMP PATENT.

WE give below the full and exact text of the decision handed down by Judge Wallace this Tuesday morning, upholding the Edison lamp patent so recently argued before him. In sustaining the patent, the court has ordered a decree for an injunction and an accounting.

THE ELECTRICAL ENGINEER is the only paper that has published a report of the arguments of counsel in this great and important suit, in which millions of dollars and the future of a leading electrical industry have been at stake. It also printed in full in its issue of June 10 the patent No. 223,898, of January 27, 1880, granted to Mr. Edison, upon which the litigation was based.

THE EDISON ELECTRIC LIGHT COMPANY vs. THE UNITED STATES ELECTRIC LIGHTING COMPANY.	*Circuit Court of the U. S. for the Southern District of New York.*

WALLACE, Circuit Judge :

Two claims of Letters Patent No. 223,898, granted Thos. A. Edison, January 27th, 1880, for an improvement in electric lamps, are in controversy in this suit. These are claims 1 and 2. It is not asserted for plaintiff that the defendant infringes the other claims of the patent, consequently they will require no attention further than to see whether their terms may assist in defining the meaning of the claims in litigation.

The plaintiff contends that these claims are for fundamental inventions of great merit, and are entitled to a construction by which every incandescent lamp for electric lighting, consisting essentially of a filamentary carbon burner, hermetically sealed in a glass vacuum chamber, is within their terms. The defendant contends that unless the claims are limited to narrow inventions, not employed by the defendant, they are invalid for want of patentable novelty. The questions of the validity and scope of the patent have been adjudicated in the Courts of England and Germany with a diversity of opinion by the Judges who have considered them. The specification is a perplexing one The difficulty lies in its shadowy demarkation of the line between the essential and non-essential features of the invention described. It catalogues a number of discoveries which Mr. Edison has made; it sets forth some of the essential features of the lamp, and then it leaves to be found by inference from generalities what the elements are of the combinations included in the extremely elastic terms of the two important claims. Nevertheless, when a sufficient knowledge of the prior state of the art to which it relates has been acquired, the new departures from old devices which it describes, and which, presumably, the inventor proposed to incorporate into the claims of his patent, are reasonably apparent. The specification states that the object of the invention is "to produce electric lamps giving light by incandescence, which lamps shall have high resistance so as to allow of the practical subdivision of the electric light." The subdivision of the electric light is the concrete term for the division of the electric current into numerous small units and their conversion into luminous centres. By practical subdivision is meant a distribution and division of the current and its conversion into lights comparable with those of ordinary gas jets, on a scale and under conditions of convenience and economy adequate to a system of illumination for domestic purposes, in villages and cities, analogous to that of gas. Prior to 1879 there was no method known by which this could be done practically. The problem involved the perfection of devices for the proper distribution and regulation of the current as well as those for translating it into light. No reference to the pre-existing devices for generating electricity, conducting it to the translating devices, or regulating its pressure and quantity, is necessary except to state that the principles governing the relation of the resistance of translating devices to the character of the circuit in which they are arranged, whether in series or in multiple arc, were well known to electricians and had been applied in various forms of electrical apparatus. There were two well-known devices for converting the current into light—the arc lamp and the incandescent lamp. In the former the current is forced to leap an air gap separating two conductors, usually of carbon, and in overcoming the resistance of the air space heats the adjacent surfaces of the conductors and produces a light of great intensity. In the latter light is produced by the incandescence of an electrical conductor, a conducting strip or burner placed in a continuous circuit through which the current passes and which develops heat by its resistance to the flow. The arc lamp was suitable for use in streets, open spaces and large halls, but its light was too concentrated and powerful for the illumination of dwellings or rooms of small dimensions. It was the generally accepted opinion of electricians that the hope of progress in the subdivision of the electric light was to be found in modifying the features of the arc lamp The reasons for this conclusion need not be mentioned ; it suffices to say that Mr. Lane-Fox in England, and Mr. Edison in this country seem to have been the only notable dissidents, and each of them had expressed the conclusion that subdivision might be accomplished by the incandescent lamp when provided with a conductor of high resistance and small radiating surface arranged in a system of multiple arc. Lane-Fox had set forth the advantages of such a lamp in three patents granted to him in England, two in October, 1878, and one in March, 1879, and in a letter to the London *Times* published in December, 1878 ; and Mr. Edison had done so in a patent granted to him in France, May 28th, 1879, for improvements in electric lighting.

By arrangement in multiple arc no greater electromotive force is required for a large number of translating devices than for a single one, and the amount of current can be graduated to the number employed ; consequently a lamp with a conductor of high resistance can be utilized as efficiently as one with a conductor of low resistance. Higher resistance in the conductor permits the use of a weaker current, and consequently, of smaller and less expensive main conductors. With a small surface of conductor less energy is required to produce a candle-power, and the small incandescent mass will radiate a moderate light, like the domestic lamp. Electricians knew how to make conductors of high resistance, and how to make them with a small radiating surface. They knew that with material of the same specific resistance the total resistance of the conductor could be varied by varying its length or cross-section, high resistance being imparted by length and small section. They knew what materials were preferable, and what processes of treatment, to make conductors of high or low resistance. If they had only known how to construct a lamp in which the conductor would have adequate mechanical strength and durability for practical commercial use, while having the small radiating surface and high resistance desirable, there would have been nothing wanting, and electric lighting by incandescence would soon have been an accomplished fact. Although Lane-Fox and Edison had contributed to the state of the art the recognition of the principle that the conductor must have high resistance and small radiating surface, and each of them had embodied the principle in lamps for which they had severally obtained patents, neither of them had invented a lamp which satisfactorily met all the conditions of success, because a burner of the necessary materials, form and complementary adjuncts was yet to be devised. As to materials, experiments had been tried with platinum, iridium and alloys of these metals, and with carbon of various kinds. It was known that platinum, being a poor conductor, could be readily brought to incandescence by the electric current, but to do so it was necessary to raise it to a temperature very near the fusing point, and a minute increase would melt it. On the other hand, carbon was known to possess at an equal temperature much greater power of radiation than platinum, but the difficulty was that it would combine with oxygen at high temperature and rapidly disintegrate. It could only be used, therefore, in a vacuum from which the oxygen had been excluded, and a perfect vacuum was practically unattainable. From the earliest lamp (disregarding the Geissler tube, because it has no burner in the true sense), patented in England by King in 1845 to the latest examples, like those of Lane-Fox or Edison's platinum lamp, patented in 1878-9, the history of the art shows a variety of experiments to perfect a lamp in which a carbon burner or a platinum burner would have sufficiently long life for practical requirements. The result of these experiments may be succinctly shown by quoting two well-known electricians. Mr. Schwendler, in an article published in 1879, in the *Telegraphic Journal*, said: "Unless we shall be fortunate enough to discover a conductor of electricity with a much higher melting point than platinum, and the specific weight and the specific heat of which conductor is also much lower than for platinum, and which at the same time does not combine at high temperatures with oxygen, we can scarcely expect that the principle of incandescence will be made use of for practical illumination." Mr. Sawyer, in a patent to Sawyer and Man, granted in June, 1878, said: "At the present day it is not new to produce a light by causing the electric current to heat a carbon conductor to incandescence in a vacuum, or in nitrogen, or in other gas; but no lamp has yet been devised which would be practically operative, and for these reasons: First, the methods which have been adopted for charging the lamp with the artificial atmosphere, such as a displacement of mercury, water or air by the gas or the combustion of phosphorus in the lamp, are imperfect. A perfect vacuum is unattainable. Some oxygen, or other element or compound, remains in the lamp, and slow consumption or disintegration takes place, for the remaining gas or vapor other than hydrogen or nitrogen attacks the carbon, which in turn is decomposed, with a result of depositing the carbon upon the globe and setting free the oxygen to attack fresh carbon. Second, it has been found practically impossible under the varying degrees of heat and pressure to maintain perfect joints, and the result is that expansion of the artificial atmosphere by the heat from the luminous conductor expels a portion of the same, and the contraction of the atmosphere upon cooling causes a portion of the external air to penetrate the globe, thus supplying oxygen, which at the next lighting feeds upon the carbon. Third, the unequal expansion of the carbon and its holders has resulted in fractures of the former, so that, however perfect the atmosphere in the globe, the lamp has never been permanent."

The most advanced type of carbon burner lamps in 1875 were the lamps of Lodyguine or of Konn, and until the spring of 1879 lamps like those of the Sawyer and Man patent or the patent of Mr. Farmer. It was thought to be the merit of Lodyguine's lamp that it obviated the difficulty of the short life of the burner by using two burners, rods of diminished section at the luminous focus in a glass receiver, hermetically sealed and filled with nitrogen, electrically arranged so that the current could be passed to the second carbon when the first had been consumed. Mr. Konn provided his lamp with five carbon burners in the form of rods or pencils and devices for bringing them successively into circuit. In the lamp of Sawyer and Man the carbon burner was a rod or pencil maintained in a globe charged with nitrogen gas, and the globe and its stopper (both of glass) were held together by a clamping device. In the lamp of the patent granted to Mr. Farmer in March, 1879, the burner was a carbon rod or pencil enclosed in a globe filled with nitrogen or other analogous gas, and the globe was closed by a rubber stopper. In none of the lamps, except the one described in Mr. Edison's prior French and English Patents of 1879, had any attempt been made to make the vacuum chamber wholly of glass with the parts sealed together by fusion, or to seal the conducting wires leading to the burner through the glass by fusion of the glass. The impracticability of maintaining a carbon burner under such conditions that it would be sufficiently durable had apparently so impressed those who were studying lighting by incandescence, that we find as late in the early part of 1879 both Lane-Fox and Edison were trying to perfect a burner of other material. Edison's burner, in his French Patent of May 28th, 1879, and his English Patent of June 17th, 1879, was of platinum wire coiled upon a bobbin composed of an infusible oxide; and Lane-Fox's burner, in his patent of May 14th, 1879, was of platinum-iridium alloy, or of spiral strips of metal surrounding a tube of glass, fire clay, steatite or lime, with the surface of the metal strips covered with asbestos or some vitreous material.

This cursory view of the prior state of the art is sufficient for an intelligent reading of the specification. The specification describes the general nature of the invention as follows:

"The invention consists in a light-giving body of carbon wire or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current, and at the same time present but a slight surface from which radiation can take place.

"The invention further consists in placing such burner of great resistance in a nearly perfect vacuum to prevent oxidation and injury to the conductor by the atmosphere. The current is conducted into the vacuum bulb through platina wires sealed into the glass.

"The invention further consists in the method of manufacturing carbon conductors of high resistance, so as to be suitable for giving light by incandescence, and in the manner of securing perfect contact between the metallic conductors or leading wires and the carbon conductor."

The specification then recites that previously light by incandescence had been obtained from rods of carbon of one to four ohms of resistance, placed in closed vessels in which the atmospheric air had been replaced by gases that did not combine chemically with the carbon; that the vessels holding the burner had been composed of glass cemented to a metal base; that the connections between the leading wires and the carbon has been obtained by clamping the carbon with the metal; that the leading wires had always been large, so that their resistance should be many times less than the burner, and generally the attempts of previous persons had been to reduce the resistance of a carbon rod. It then points out the disadvantages of such a lamp, stating that it could not be worked in great numbers in multiple arc without the employment of main conductors of enormous dimension; that, owing to the low resistance the leading wires have to be of large dimensions and good conductors, and a glass globe cannot be kept tight at the place where the wires pass in and are cemented, and consequently the carbon is consumed, because there must be almost a perfect vacuum to render it stable, especially when it is small in mass and high in electrical resistance; and that the use of gas in the receiver at the atmospheric pressure serves to destroy the carbon by attrition.

The specification then states in substance that the patentee proposes a new departure; and that he has discovered that even a cotton thread properly carbonized and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere, offers from one hundred to five hundred ohms resistance to the passage of the current, and that it is absolutely stable at very high temperature; that if the thread be coiled as a spiral and carbonized, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled, as much as two thousand ohms resistance may be obtained without presenting a radiating surface greater than three-sixteenths of an inch; that if such fibrous material be rubbed with a plastic composed of lamp-black and tar its resistance may be made high or low, according to the amount of lamp-black placed upon it; that carbon filaments may be made by a combination of tar and lamp-black, the latter being previously ignited in a closed crucible for several hours, and afterwards moistened and kneaded until it assumes the consistency of thick putty; that small pieces of this material may be rolled out in the form of wire as small as seven one-thousandths of an inch in diameter and over a foot in length; and the same may be coated with a non-conducting, non-carbonizing substance and wound on a bobbin, or as a spiral, and the tar carbonized in a closed chamber by subjecting it to high heat, the spiral after carbonization retaining its form; that he has carbonized and used cotton and linen thread, wood splints, papers coiled in various ways, also lamp-black, plumbago and carbon in various forms mixed with tar and kneaded so that the same may be rolled out into wires of various lengths and diameter; that each wire should be uniform in size throughout; that all these forms are fragile and cannot be clamped to the leading wires with sufficient force to ensure good contact and prevent heating; that if platinum wires are used and plastic lamp-black and tar material be moulded around it in the act of carbonization, there is an intimate union by combination and by pressure between the carbon and platinum, and nearly perfect contact is obtained without the necessity of clamps; that the burner and leading wires should be connected to the carbon ready to be placed in the vacuum bulb, and when fibrous material is used the plastic lamp-black and tar should be used to secure it to the platina before carbonizing.

The specification proceeds as follows:

"By using the carbon wire of such high resistance I am enabled to use fine platinum wires for leading wires, as they will have a small resistance compared to the burner, and hence will not heat and crack the sealed vacuum bulb. Platina can only be used as its expansion is nearly the same as that of glass.

"By using a considerable length of carbon wire and coiling it, the exterior, which is only a small portion of its entire surface, will form the principal radiating surface; hence I am able to raise the specific heat of the whole of the carbon and thus prevent the rapid reception and disappearance of the light, which on a plain wire is prejudicial, as it shows the least unsteadiness of the current by the flickering of the light, but if the current is steady the defect does not show."

The specification then gives directions for carbonizing the carbon thread in a manner to prevent its distortion, for blowing a glass bulb over it after it is formed, for exhausting the glass bulb, and for hermetically sealing the bulb when a high vacuum has been reached.

The claims are as follows:

"1. An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance made as described, and secured to metallic wires, as set forth.

"2. The combination of carbon filaments with a receiver made entirely of glass and conductors passing through the glass and from which receiver the air is exhausted, for the purposes set forth.

"3. A carbon filament or strip coiled and connected electric conductors so that only a portion of the surface of such carbon conductors shall be exposed for radiating light, as set forth.

"4. The method herein described of securing the platina contact wires to the carbon filament, and carbonizing of the whole in a closed chamber, substantially as set forth."

The specification is addressed to those who were skilled in the art to which it relates; who appreciated the advantages of arranging incandescent lamps in a system of multiple arc, and of providing the lamp with a burner of high resistance and small radiating surface; who knew how high resistance, both specific and total, is imparted to a conductor; who knew that the rods, pencils, or other forms of carbon burners previously used, had not been designed to embody the principle of high resistance; who knew how desirable it was to maintain the burner in a perfect vacuum, or in gases that would exclude the oxygen; who knew what had been attempted and had proved impracticable in that behalf; who knew that such materials as are mentioned in the specification (even the tar-putty compound seems to have been used in Gauduin's process) would compose a carbon of high resistance when subjected to a proper process of carbonization; and who knew how to practice proper processes for the carbonization of such materials.

Read by those having this knowledge, the radically new discovery disclosed by the specification is that a carbon filament as attenuated before carbonization as a linen or cotton thread, or a wire seven one-thousandths of an inch in diameter, and still more attenuated after carbonization, can be made which will have extremely high resistance and be absolutely stable when maintained in a practically perfect vacuum. It informs them of everything necessary to utilize this discovery and incorporate it into a practical lamp. It describes, with the assistance of the recital in the second claim, as the vacuum in which the burner is to be maintained, a bulb made wholly of glass exhausted of air, sealed at all points by the fusion of the gas, and in which platinum leading wires are sealed by the fusion of the glass. It describes the materials of which the burner is to be made and instructs them that the materials are to be shaped into their ultimate form before carbonization. It describes the use of platinum for the leading wires, and a method of securing the leading wires and filaments, intending to dispense with clamping, which consists in molding tar putty about the joints, and carbonizing the whole in a closed chamber. Besides stating that the resistance of the burner will be greatly increased and the radiating surface still be kept within moderate limits by coiling it in the form of a spiral, the specification states that by increasing the length of the filament coiled, the exterior only will be the principal radiating surface, and greater steadiness of illumination will be promoted.

The first claim must be read with several limitations. The filament is to be made of carbon of high resistance; that is, as the experts agree, of high specific resistance. The filament is to be made as described; that is, the materials are to be of some of the kinds described, and are to be shaped in filamentary form and then carbonized. The filament is to be secured to metallic wires according to the method of the patent, because the claim implies the elements of a globe and metallic conductor arranged in circuit with the burner, otherwise the combination would not be operative and it would have been needless to specify the securing of the metallic wires to the filament, unless it was intended to import into the claim the specific method of doing so emphasized in the specification.

The defendant does not infringe this claim, if for no other reason, because the leading wires in its lamps are not secured to the filament according to the method of the patent; that is, by cement carbonized *in situ*, but by clamps such as the specification condemns.

The second claim is broad enough in its phraseology to secure the real invention described in the specification, and can be read consistently with its language so as to import into it every essential limitation.

It was a remarkable discovery that an attenuated thread of carbon would possess all the long-sought qualities of a practical burner when maintained in a perfect vacuum. The extreme fragility of such a structure was calculated to discourage experimentation with it, and it does not detract in the least from the originality of the conception that previous patents had suggested that thin plates or pencils or small bridges could be used. The futility of hoping to maintain a burner in vacuo with any permanency had discouraged prior inventors, and Mr. Edison is entitled to the credit of obviating the mechanical difficulties which disheartened them, but what he did in this respect was a matter of only secondary merit and was no longer new in the art, because he had already disclosed it in his French and English Patents. What he actually accomplished was to unite the characteristics of high resistance, small radiating surface and durability in a carbon conductor by making it in a form of extreme tenuity, out of any such materials as are mentioned in the specification, carbonizing it, and arranging it as he had previously arranged his platinum burner in an exhausted bulb made wholly of glass and sealed at all points, including those where the leading wires entered, by the fusion of the glass. He was the first to make a carbon of materials and by a process which was especially designed to impart high specific resistance to it—the first to make a carbon in the special form for the special purpose of imparting to it high total resistance, and the first to combine such a burner with the necessary adjuncts of lamp construction to prevent its disintegration and give it sufficiently long life. By doing these things he made a lamp which was practically operative and successful, the embryo of the best lamps now in commercial use, and but for which the subdivision of the electric light by incandescence would still be nothing but the *ignis fatuus*, which it was proclaimed to be in 1879 by some of the learned experts who are now witnesses to belittle his achievement and show that it did not rise to the dignity of an invention.

The coiled form of the burner is only an alternative feature, and is not a constituent of the second claim. It is the subject of the third claim. Nor is the bent form or any form other than the filamentary. It may be that in the haste which has always seemed to characterize Mr. Edison's efforts to patent every improvement, real or imaginary, which he has made or hoped to make, he had not stopped to reflect when he framed his application for the patent that the filamentary burner would do its work just as well uncoiled as coiled, provided the same length and cross-section were used. It is true that it is said in the general statement of the nature of the invention that the burner is so "coiled or arranged" as to offer high resistance and present a small radiating surface; but this description is satisfied by any arrangement, whether by coiling a considerable length in a small globe or using the same length uncoiled in a larger globe, by which sufficient total resistance is obtained from a filament of small diameter. It certainly would not involve invention to omit the coiling and elongate the globe; hence, it is manifest that the invention described is the same thing essentially whether the coiled form is used or not. The language is satisfied, if the burner is filamentary and so arranged as to offer great resistance and slight radiation, without importing into it anything which is not of the essence of the invention. No precise limitation upon the maximum diameter of the filament can be defined from the specification or is required as an element of the claim. The specification mentions by way of illustration the threads of linen or cotton which become more attenuated after carbonization, and the carbon wire which after carbonization would be from four to five one-thousandths of an inch in diameter; while the smallest rods of carbon previously known were about a millimeter in diameter, thus having a cross-section fifty times as great as the carbon wire. It is to be implied from the suggestions in the specification that it is to have sufficiently high total resistance for efficient use when the lamps are arranged in multiple arc, and to be used with leading wires of fine platinum. The claim is not limited to a carbon filament made of non-fibrous material. The conductors of the claim are the platinum wires mentioned in the specification. The receiver is the vacuum described in the specification. The peculiar method of securing the conductors to the filament, made a constituent of the first claim, is not imported into the second claim. A more exact interpretation of the meaning of the claim than has thus been indicated is not necessary in the present case, because each of the three lamps representing the kinds used by the defendant embodies the invention of the claim as thus interpreted.

It is of little import what Mr. Edison, or his patent solicitor, may have thought about the meaning of the claim during the pendency of the application for a subsequent patent, or that Mr. Edison may have supposed a resistance as high as one hundred ohms in the burner would be required for use with the means of distribution which he expected to employ with his system of lighting. There are many adjudicated cases in which it appears that the inventor builded better than he knew; where a patent has been sustained for an invention the full significance of which was not appreciated by the inventor when it was made. In the case of the Bell Telephone patent there was great room for doubt whether the speaking telephone had been thought of by Mr. Bell when he filed his application for a patent, but the Court said: "It describes apparatus which was an articulating telephone, whether Bell knew it or not" (22 Blatch., 532).

The nearest approach in the prior art to the invention of the second claim is undoubtedly the lamp of Edison's French and

English Patents with a platinum burner. It seems almost preposterous to argue that the substitution of the carbon filament for the platinum burner of that lamp was an obvious thing to electricians. It would have been probably if there had been such a thing as a filamentary carbon in the prior art. But the nearest approximations to it were the ribbon-shaped carbon burner of low resistance of Mr. Farmer (which was not a part of the prior art but an isolated example known only to a select few) and the low resistance carbon rod burners of the patent of Sawyer and Man.

Undoubtedly the improvements that have been made in the art, such for instance as the method of electrical carbonization of the filament, since Mr. Edison's invention, have been of great value, and the perfected commercial lamp of to-day is far superior to the one which could be made by applying to the description of the patent all the knowledge and skill then possessed by those to whom it was more particularly addressed. But as was said by Bowen, L. J., in the Court of Appeal in England, "the evidence shows that lamps made solely on the patent will and do succeed, although subsequent improvements have been engrafted on the original design." It is impossible to resist the conclusion that the invention of the slender thread of carbon as a substitute for the burners previously employed opened the path to the practical subdivision of the electric light.

The questions which have seemed the most meritorious of those argued at the bar have now been considered. Others, to which no reference has been made, have not been overlooked, and may be dismissed without discussion and with the single remark that nothing which has been presented by the voluminous proofs and the exceedingly able and elaborate arguments of counsel seems to supply any valid reason for refusing to decree for the plaintiff.

The usual decree for an injunction and accounting is accordingly ordered.

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THE FRANKFORT INTERNATIONAL ELECTRICAL EXHIBITION—II.

BY

Richard O. Heinrich.

The Electric Grotto.

IN my previous communication, I referred to the artistic arrangement of the buildings and grounds of the Exhibition, but a far better idea may be obtained from the accompanying photograph of the Machinery Hall. The view is the work of Messrs. Wiesbaden & Co., of Frankfort.

The front of Machinery Hall, it will be noted, has a model railroad line with electric signals, demonstrating the operation of these very important adjuncts to railway work. One of the most picturesque spots in the Exhibition is the grotto and waterfall, which are electrically illuminated, and an idea of which will be obtained from the vignette engraving.

As I write, there is just going out the call for the International Electrical Congress, to be held from the 7th to the 12th of September, at Frankfort. It is proposed to organize into sections, as was the case with former Congresses, and to discuss the prominent electric topics of the day. Among the papers already promised I may mention the following, together with their authors:

CARHART: 1. The Substitution of Dynamo Machines for Voltaic Batteries in Telegraphy. 2. Current Regulators for Dynamo Machine.

DOLBEAR: Electrical Terminology.

VON DOLIVO DOBROWOLSKY: Electrical Transmission of Power by Alternating Currents.

EPSTEIN: Applicability of Electro Magnetic Measuring Instruments, that is, those containing iron, for Alternating Currents.

FEUSSNER: Material and Construction for Measuring Instruments.

FRÖLICH: 1. Objective Demonstration of Harmonic Curves, and Electro-Acoustic Experiments. 2. Generation and Application of Ozone.

HOLBORN: On the Magnetic Action of different Iron Alloys.

HUMMEL: Direct determination of the work of Magnetization and the Currents in an Iron Ring.

KAHLE: The Permissible Limits of Error in Measuring Instruments, in Relation to Heat, Remanent Magnetism, etc.

KAREIS: 1. Prevention of Cross-Talk in Telephone Wires Strung on the Same Pole. 2. Prevention of Disturbances in Telephone Circuits by Induction from Wires Carrying Heavy Currents. 3. Improvements in the Conductivity of Telegraph Lines.

KOHLRAUSCH: What is the Best Course of Study for the Education of the Electrical Engineer.

LÖWENHERZ: Introduction of Uniform Screws in Electrical Work and Instrument Making.

MAY: Regulations for Electrical Conductors from the Standpoint of the Fire Insurance Companies.

MEISSNER: Application of Lippmann's Capillary Electrometer to Cable Telegraphy.

MULLER: Arrangement of Storage Batteries for Light and for Heavy Work.

PEUKERT: On Electric Meters.

ROTHEN: Important Questions in the Domain of Telephony.

Papers have also been promised by Dubois, Ferraris, Grawinkel, Quincke, Alioth, Arnold, Görges, Slaby, and others.

Besides the purely electrical character of the Congress, its social side has by no means been forgotten. The evening of the first day will be occupied by a general reunion and reception of the delegates. On the second day there will be a gala performance in the Exhibition Theatre, followed by a banquet in the hall of the large restaurant in the Exhibition ground. On the third day the delegates are invited to attend a banquet in the great hall at the Palmengarten, which will be followed by promenade double concert. On the fourth day there will be an entertainment given at the Marine Exhibition, including a

MACHINERY HALL, FRANKFORT ELECTRICAL EXHIBITION.

vocal concert and the illumination of the banks of the river. On the fifth day there will be a gala performance at the Frankfort Opera House. On Saturday, September 12th, the last general meeting of the delegates takes place, and at 7 o'clock in the evening, there will be a grand ball in the hall of the Zoölogical Gardens.

Not satisfied with all these entertainments, the Committee has arranged for the following day, Sunday, September 13th, an excursion with special trains to Wiesbaden. Delegates will spend the day there and in the evening will be entertained at a large garden party in the great Kur-Park, accompanied by fireworks.

Those who propose to take part in the Congress will have to be provided with a ticket, which can be procured for the very moderate sum of 16 marks ($4), Ladies' tickets are 10 marks ($2.50). Application for tickets must be made to the *Vorstand der Electrotechnischen-Gesellschaft* *zu Frankfort a. M.* I may add that Dr. von Stephan, Secretary of State for Postal Telegraphs, has been asked to accept the Honorary Presidency of the Congress by the issuers of the call, and Dr. Werner v. Siemens will occupy the chair at the opening session of the Congress.

THE DYNAMICS OF A DYNE AS A UNIT OF FORCE.

BY

John A. Grier

PROFESSOR SILVANUS THOMPSON makes an apt quotation when he says: "Science is measurement."

Electrical units are the foundation of electrical measurements, and hence of the scientific study of electricity. Is it not a fact that, generally, there is not a very earnest attempt to grasp the true meaning of the units most commonly used? I admit that they are difficult to comprehend.

I will not touch on the more practical units, the volt, the ampere, the ohm, or any other except the dyne. As these others are all derived from the dyne, and are measured by it, let us glance at this unit with closer attention. A dyne is defined as "that force which, acting for one second on a mass of one gramme, gives to it a velocity of one centimetre per second."

A gramme is a weight with which many of us are not familiar—while a United States dime is handled by all of us daily. The legal weight of a dime is two and a half grammes, thus four-tenths of a dime will weigh one gramme. We also know that a centimetre is nearly four-tenths of an inch in length, as .3937 of an inch is almost .4. Thus, we may roundly define a dyne in language that will be more likely to stick to the memory and be more easily grasped by some if we slightly paraphrase the definition and say it is that force which, acting for one second on a mass of matter equal in weight to four-tenths of a dime, gives to it a velocity of almost four-tenths of an inch per second.

Now let us see what will be the total effect of expending one dyne in raising one gramme from rest in a vertical direction. The velocity to be produced is one centimetre per second. As the body is at rest at the commencement of the action and reaches a final velocity of one centimetre per second, then the space passed over, or the distance the body will be raised, is only a half centimetre. Then the force is all expended on the gramme, but the gramme will continue in motion after the expiration of the second until gravity overcomes this momentum. By the well-known laws which govern bodies moving in opposition to gravity alone, we find that the gramme will move on in a vertical direction during a little more than the one-thousandth of a second, and will ascend about two ten-thousandths of an inch higher. Thus, a dyne will lift our gramme one-half a centimetre during the second, and then it will ascend about two ten-thousandths of an inch farther. This is the total measure of one dyne as far as space is concerned.

Let S = space it would pass through after the end of the second when it had acquired a velocity (V) of .3937 inch per second.

By the formula, $S = \dfrac{V^2}{2\,g}$;

let g represent the acceleration or retardation of a body left free to the action of gravity. Gravity will produce or retard a motion of about 386 inches per second when left free to act on a body in certain places on the earth's surface having a fixed relation to the earth's centre and distance from the equator. Then we have

$$S = \frac{.3937^2}{2 \times 386} = .0002+.$$

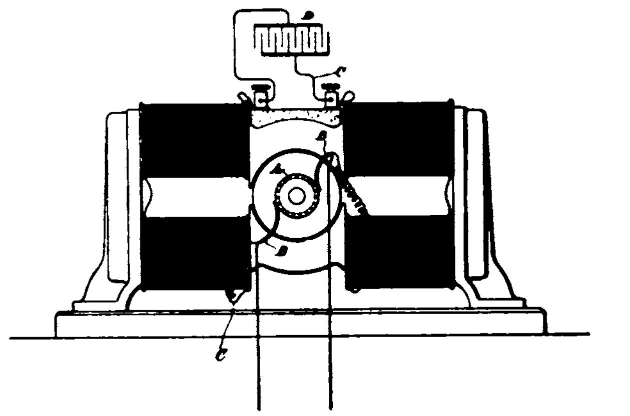
As we have slightly overrated the length of the centimetre, we find on a nicer calculation that the space moved over by the gramme is a trifle less than two ten-thousandths of an inch. In either case the motion could scarcely be measured as it would only be a slight tremor.

It should be observed that gravity will produce about 960 times as much motion on a gramme when left free to act on it, as a dyne will in acting in opposition to gravity.

The minuteness of all electrical units is a troublesome feature in comprehending their meaning, and the dyne partakes of this feature. *A clear conception of a dyne is the bed-rock of electrical science.*

THE STANLEY AND KELLY ALTERNATING CURRENT MOTOR.

IF a shunt-wound, continuous current motor be operated by an alternating current, a loss is occasioned by the high self-induction of the field-circuit, which retards the phase of the current-imparting magnetism to the field-magnets, and, as a consequence, the maximum magnetic effects of armature and field are not coincident, a condition which impairs the efficiency of the motor. In order to counteract this, and to bring the maximum magnetic conditions of the two elements, armature and field, more nearly into coincidence, Messrs. William Stanley, Jr., and John F. Kelly have devised a method of introducing into the field-circuit a condenser, which has the effect of bringing the phase nearer to that of the impressed electromotive force of the source of current. The efficiency and economy of this disposition will, of course, depend upon the electromotive force, rate of change of the current, and other well-understood conditions.



STANLEY AND KELLY ALTERNATING CURRENT MOTOR.

The device is clearly shown in the accompanying illustration, which represents an ordinary shunt-wound motor with a condenser included in the field-circuit.

THE HAYES-HIBBARD BATTERY TERMINAL.

IN battery circuits it is, of course, advantageous to eliminate all unnecessary resistance, and that caused by the corrosion of terminal contacts has always been a source of annoyance and loss. Messrs. H. V. Hayes and A. S. Hibbard, of the Long Distance Telephone Co., have perfected a method of making contacts intended to obviate this difficulty and keep the resistance at the lowest possible point. To accomplish this the connections are made by means of a soldered joint, the solder being carried upon one or both of the wires to be connected, so that it is only necessary to twist them together and apply a moderate heat, such as that of a candle or spirit lamp. Perfect connections are thus made with the greatest facility, and the joint can be readily broken in a like manner.

THE WIGHTMAN SINGLE-REDUCTION RAILWAY MOTOR.

Among the very first to recognize the desirability of as well as the possibility of eliminating one set of transmission gears in electric street railway cars was Mr. Merle J. Wightman, who, as electrician of the Wightman Electric Manufacturing Co., of Scranton, Pa., over a year ago commenced experiments towards the development of a slow-speed single reduction motor. The results of this work are embodied in the motor shown in the accompanying engraving, Fig. 1, from which it will be seen that the "Kennedy" type of field-magnet is employed. This form of field-magnet has the advantage of almost completely covering the field coils and producing an "iron-clad" motor. It gives a very strong and efficient field and all four poles are excited by two field windings.

The armature is of the Gramme type, and the commutator is cross-connected so that but two brushes are used, placed at an angle of 90 degrees and on top of the commutator.

The cross-connecting of the commutator is accomplished in a remarkably simple way. All the crossing cables are formed symmetrically into a flat disc which is firmly bolted to the head of the commutator and becomes an integral part of it. In this way all possibility of vibration and risk of breakage is overcome. The commutator lead-wires are all of flexible cable, after the Wightman Company's well-known method of armature winding. These lead-wires are fastened to the commutator without screws and in such a way that they can be detached in a few minutes, when it becomes necessary to remove a commutator. The armature is mounted within a strong, continuous frame forming part of the field-magnets. The bearings are self-oiling and dust-proof and are designed to be used with grease, oil, or both.

Either field winding is removable without disturbing the other or the armature, each winding being made up of separate coils, one of which is shown in Fig. 2. The removal of two bolts at one end makes it possible to lift out one of the fields, after which the armature can be taken out. The top field pole is hinged at one end for convenience in removing the fields or armature.

The ratio of the reduction of the gearing is 4.4 to 1, the armature pinion having fifteen teeth and a diameter of five inches. This ratio gives about 480 revolutions of the armature at a car-speed of 10 miles an hour.

The aim of the designer of the Wightman motor has been to attain as great an efficiency as possible with the wide variation of speed and load met with in street railway practice. This has been obtained by means of large field magnets of a great number of turns of wire. In fact, speed regulation is obtained without the use of any external resistance above three or four miles an hour. On a level, cars equipped with two 20 h. p. Wightman motors have frequently attained a speed above twenty-five miles an hour.

Mr. Wightman's experience has led him to the belief that there is no economy in operating motors of small capacity. Many roads are operated in such a way that cars are barely maintained on schedule time by dangerous and reckless running on down grades. A little calculation will show that by the expenditure of a little more power grades may be climbed rapidly, and as a result, much more service can be gotten from a given expenditure in wages for conductors and motor-men and interest on plant; and the cost of the extra coal will be comparatively insignificant. It is much safer to climb grades rapidly rather than to descend them at a high rate of speed, not to mention the greater satisfaction of patrons. When climbing a grade a stoppage of power and application of brakes will bring a car to a standstill within surprisingly short distance. Since the wear and tear of ample-sized motors is obviously less than those overworked, all considerations of economy and safety would therefore point to the use of the former.

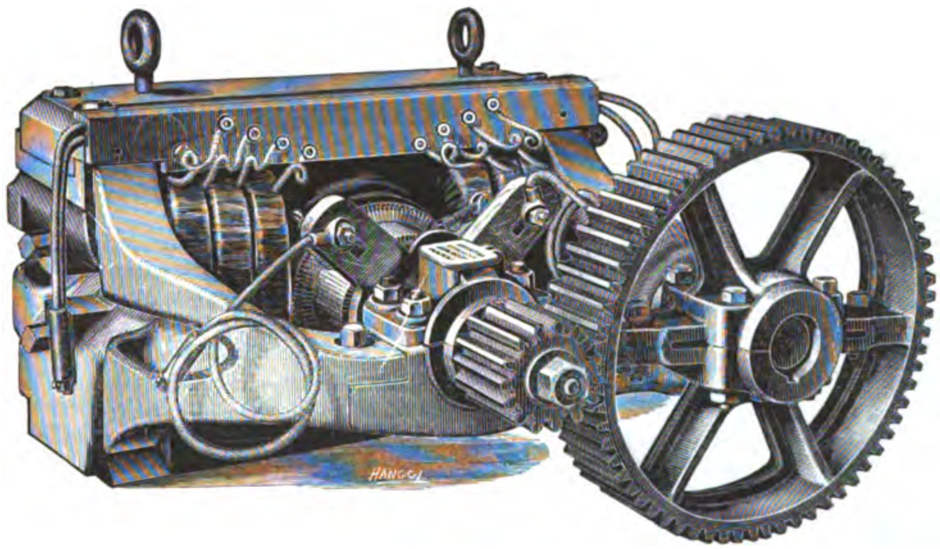


Fig. 1.—Wightman Single Reduction Railway Motor.

While in the Wightman motor electrical perfection has not been sought for at the expense of simplicity and durability, a very high efficiency is obtained. The armature resistance of the 20 h. p. motor is .75 ohm, and that of the main field coils .15 ohm, with a load of 40 amperes, or over 26 electrical horse power; this would give a loss of potential in the motor of 36 volts, or an electrical efficiency of 92.8. Even with this excessive load the commercial efficiency has been found to be as high as 87 per cent. The large field, referred to above, makes possible a high efficiency at low speed and light loads. These qualities are synonymous with powerful torque or starting force. A loaded car equipped with Wightman motors requires not more than from 15 to 20 amperes to start on a level.

Not the least interesting improvement in car equipment is the new controlling device employed by the Wightman Co., shown in perspective in Fig. 3. Here, again, simplicity and durability have been the aim of the designer. Corresponding points in each controller are connected at each end of the car, and all mechanical contrivances beneath the car, such as reversing switches, rheostat cables, etc., are done away with. There are five speed contacts on each side of the middle stop. A movement of the controller handle to the left causes the car to go forward, while an opposite movement reverses the direction of motion. The gradation of resistance on the reversing side of the controller is such that a car can be brought either slowly or suddenly to a standstill without the use of brakes or undue strain on the motors. The control is as absolute and flexible as in the case of a steam locomotive, yet very much more convenient in operation. The top of the controller is provided with notches in which a catch on the operating handle engages. This arrangement enables the motor-man to confine his attention to the track ahead, and yet be aware of the position of the controlling lever.

Another valuable feature of the controller is the device for extinguishing the arc formed on breaking contact. This consists of a small magnet let in from the back of the slate base and the poles of which come directly opposite

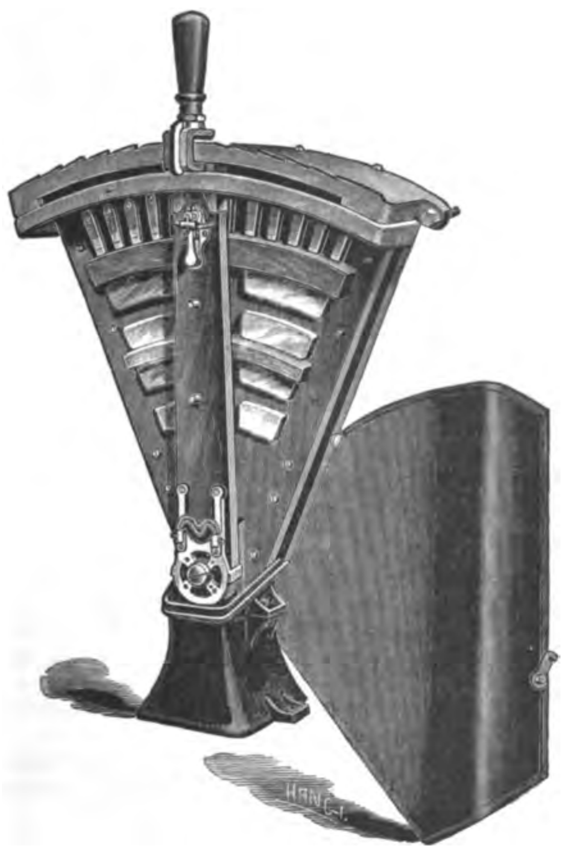


FIG. 3.—CONTROLLING DEVICE OF WIGHTMAN SINGLE REDUCTION RAILWAY MOTOR.

the spaces between the contacts; the well-known action of the magnet serves to blow out the arc and thus preserves the contacts. The latter in addition are all arranged to be readily removable for renewal, in case of necessity, and for this purpose all connections are in sight and can be gotten at merely by removing the cover.

Another interesting feature is the rheostat employed; this consists of very thin sheet-iron rings, slit and lapping over each other slightly, making a continuous spiral; the convolutions are insulated from each other by mica and liquid glass, and when the whole is screwed up tight it makes a perfectly fire-proof rheostat 3 inches in diameter and only 18 inches long. It has a resistance of 12 ohms and is divided into two sections.

The motor suspension adopted by the Wightman Co. consists of a regular carriage spring, which makes it very flexible and easy riding. The motor is thoroughly protected from dust and the gear case is built up in halves, which are hinged at the centre, so that one slides within the other; to open this case requires the loosening of but a single thumb-screw. The weight of the motor complete

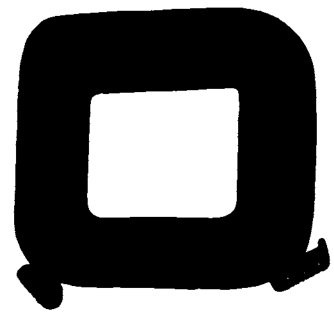


FIG. 2.—FIELD WINDING OF WIGHTMAN SINGLE REDUCTION RAILWAY MOTOR.

is 2,200 lbs. We may add that the Wightman motors are now in successful operation in Auburn, N. Y., Scranton and Easton, Pa.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—VIII.

BY

Chas. Steinmetz.

In Fig. 14 the diagram for constant primary impressed E. M. F. is drawn for the secondary resistances.

1. $r_1^{\,1} = 2$ ohms: full load.
2. $r_1^{\,2} = 4$ ohms: half load.
3. $r_1^{\,3} = \infty$: no load.

Thus, if the primary impressed E. M. F., E_0, is kept constant, and the secondary resistance varies from 2 ohms, for full load, to ∞, for no load, the maximum primary impressed E. M. F. moves from $E_0^{\,1}$ to $E_0^{\,3}$, on the arc e_0, which, because of its shortness, can be replaced by a straight line.

Primary resulting E. M. F., E, primary M. M. F., L, and primary current, C, travel on the lines e, l, c, decreasing for decreasing load, while the difference of phase between primary current and impressed E. M. F. increases with decreasing load.

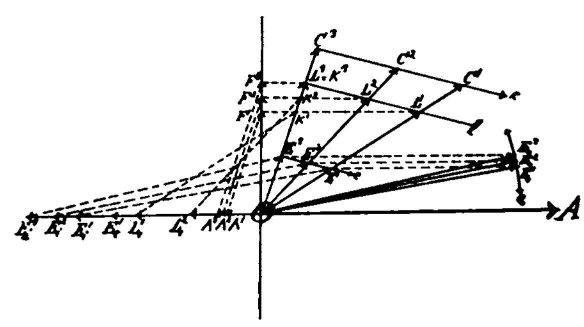


FIG. 14.

The resulting and the impressed M. M. F. increase with decreasing load, from F^1 and K^1, respectively, to F^3 and K^3, and hence the induced E. M. F.'s decrease with increasing load, from $E_1^{\,3} = E_1^{\,3}$ to $E_1^{\,1} = E_1^{\,1}$, etc.

The secondary terminal pressure, E_1, decreases still more with increasing load, because of the drop of potential caused by the internal resistance of the secondary coil, $E_1 = E_1^{\,3}$ for open secondary circuit, and decreases to $E_1^{\,1}$ for full load.

This construction of the diagram for constant primary impressed E. M. F. is not absolutely exact, because we supposed the angle of magnetic lag $\alpha = \text{K O F}$, to be constant; while it slightly decreases with increasing magnetization, but the increase of the magnetization from full load to no load, *i. e.*, from $\overline{\text{O F}^2}$ to $\overline{\text{O F}^1}$, is so small in good constant potential transformers, that we can allow this approximation. Where, for instance, as in constant-current transformers, the change of the magnetization is large enough to cause a perceptible change in the angle of magnetic lag, we have to replace the ray $\overline{\text{O K}}$ by that curve, which gives the dependence of the magnetic lag upon the magnetization. Chapter VIII. on "Constant Current Transformers," will contain more on this subject.

In the same way as we did here, by producing the diagrams for constant secondary E. M. F., E_1 and then increasing or decreasing all the quantities proportionally, we can produce the diagram of the transformer, which gives constant potential at the secondary terminals, and therefrom determine the changes of primary impressed E. M. F., necessary to be produced by the dynamo alternator, to give constant voltage at the secondary terminals.

Thus, in Fig. 15, is shown the diagram of the transformer for full load, E_0^1, E^1, E_1^1, C^1, etc., and for open secondary circuit, under the condition that the secondary terminal pressure at full load, E_1, is equal to the secondary E. M. F. at open circuit. E_0, E, L, C, then move along the lines e_0, e, l, c, and the dynamo alternator has for increasing load to increase its E. M. F. from $\overline{\text{O E}_0}$ on open secondary circuit up to $\overline{\text{O E}_0^1}$, for full load, to keep the pressure at the secondary terminals constant. At the same time we see, that : *If different transformers are fed by the same dynamo alternator, and the load on the transformers is different, it is not possible to regulate the* E. M. F. *of the dynamo so that the secondary terminal pressure of all the transformers is constant.*

Hence it is of the utmost importance to design parallel transformers so, that for constant primary impressed E. M. F. the pressure at the secondary terminals is as constant as possible, for varying load, and either to keep the E. M. F. of the dynamo alternator constant, or, better, to regulate it so as to keep constant pressure at the centre of distribution.

Means to accomplish this good compounding of the con-

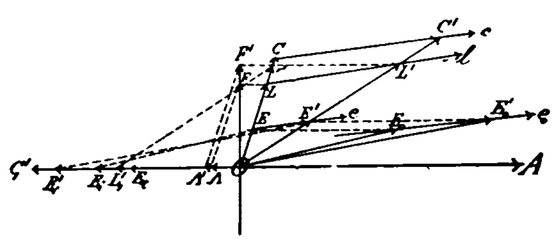


FIG. 15.

verters we derived from the foregoing, and shall consider them still more in the following.

Good compounding generally means low internal resistance of transformer and line ; low self-induction, that is, low magnetic leakage ; low magnetic resistance, P; high frequency, N; large number of turns, n and n_1; low magnetization, F; low hysteresis and eddies, A, etc.

B. Dependence upon the Primary Resistance, r.

The letter r is understood to represent the electric resistance between those two points of the primary conductor between which E_0 was the maximum E. M. F. Thus r is the internal resistance of the primary coil, if E_0 is the potential difference at the primary terminals of the converter. If r is the whole electric resistance of the primary circuit, E_0 is the E. M. F. of the dynamo alternator, etc.

Let r change from r_0^2, the internal resistance of the primary coil, to r^1, the whole resistance of the primary circuit, that is, let us go along the primary line from the converter to the dynamo.

Then, in Fig. 16, $C, L, F, K = \text{L}^\infty$, etc., remain constant, but E increases from E^2, consumed in the primary coil proper, to E^1, consumed in the whole primary circuit, and E therefor travels on the ray $\overline{\text{O E}}$ from E^2 to E^1, for full load. Similarly, for open secondary circuit, E^∞ changes from $\text{E}^{\infty\,2}$ to $\text{E}^{\infty\,1}$, on the ray $\overline{\text{O E}^\infty}$. Hence, because of the parallelogram of primary E. M. F.'s, E_0 (full load) and E_0^∞ (open circuit) travel on the lines e_0 that is, e_0^∞, from E_0^2 at the primary terminals, up to E_0^1 in the dynamo ; that is, from $\text{E}_0^{\infty\,2}$ to $\text{E}_0^{\infty\,1}$.

At the same time, when r increases, that is, when we go farther away from the transformer terminals, on the

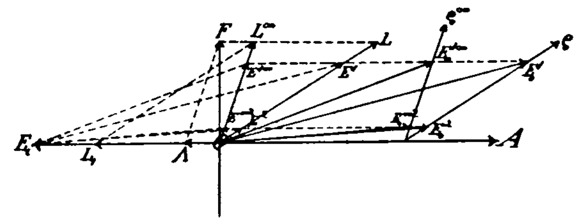


FIG. 16.

primary line, the difference of phase between primary current and primary E. M. F.,

angle $\omega = \text{L O E}_0$ for full load, that is,
angle $\omega^\infty = \text{L}^\infty \text{O E}_0^\infty$ for open secondary circuit,

decreases, especially for open secondary circuit, but much less for full load.

Hence the difference of phase between current and E. M. F. in alternating transformer circuits, and in all inductive circuits, is not a constant, but varies from point to point on the line, increasing with the increasing distance from the dynamo.

Thus, in inductive circuits, we have not only a drop of potential in the line, but also an increase of the shifting of phase by approaching the inductive part of the circuit, except in the case where the inductance is distributed over the whole circuit proportional to its resistance; but then the loss of potential in the line is considerably less than the line resistance accounts for.

For instance, in the transformer, Fig. 16, for open secondary circuit, the potential difference at the primary terminals of the transformer is :

$\overline{\text{O E}_0^{\infty\,2}} = 136$ volts, and at the dynamo, $\overline{\text{O E}_0^{\infty\,1}} = 162$ volts. Hence a loss in the line, of $\overline{\text{O E}_0^{\infty\,1}} - \overline{\text{O E}_0^{\infty\,2}} = 26$ volts.

But, the resistance of the whole circuit being r^2; the resistance of the primary coil proper, r^1; the E. M. F. consumed by the resistance of the line, $r^2 - r^1$, is :

$$\overline{\text{O E}^{1\infty}} - \overline{\text{O E}^{\infty\,2}} = 60 - 12 = 48 \text{ volts};$$

that is, the line consumes 22 volts pressure less than in an equivalent continuous current circuit.

I need not remark that the consumption of energy in the line is the same for continuous currents as for alternating currents of equal strength ; only that in the alternating system the greatest part of this energy is furnished by a shifting of phase ; in the continuous current system it must be furnished by a drop of potential. This is especially marked, where the line is of low self-induction, and the working apparatus of high self-induction. If the working part is of low self-induction (for instance incandescent lamps), and the line has a considerable self-induction, just the opposite phenomenon appears the line consumes more potential than its resistance accounts for, and the difference of phase between current and potential difference increases, when approaching the dynamo alternator.

But these phenomena of self-induction, I suppose, are so well understood, that I need not dwell upon them any longer.

TESLA'S ELECTROLYTIC METER.

THE measurement of the quantity of current taken by consumers has given rise to a large variety of meters, one type among these being what are known as electrolytic meters. Probably the best known of this class is the Edison meter in which the quantity or weight of metal deposited from one plate upon another affords a measure of the current passed through the circuit. In other forms the quantity of gas decomposed by the passage of the current gives the desired indication.

In seeking to employ the electrolytic deposition of a metal for this purpose, but to avoid the manipulation required in weighing the plates in order to ascertain the loss in weight, Mr. Nikola Tesla makes use of an electrolytic cell, through which extend two conductors parallel and in close proximity to each other. These conductors are connected in series through a resistance, but in such manner that there is an equal difference of potential between them throughout their entire extent. The terminals of the conductors are connected either in series in the circuit supplying the current to the lamps or other devices, or in parallel to a resistance in the circuit, and in series with the translating devices. Under such circumstances a current passing through the conductors establishes a difference of potential between them which is proportional to the strength of the current, in consequence of which there is a leakage of current from one conductor to the other across the solution. The strength of this leakage current is proportional to the difference of potential, and, therefore, in proportion to the strength of the current passing through the conductors. Moreover, as there is a constant difference of potential between the two conductors throughout the entire extent that is exposed to the solution, the current density through such solution is the same at all corresponding points, and hence the deposit is uniform along the whole of one of the conductors, while the metal is taken away uniformly from the other. The resistance of one conductor is by this means diminished, while that of the other is increased, both in proportion to the strength of the current passing through them. From such variation in the resistance of either or both of the conductors forming the positive and negative electrodes of the cell, the current energy expended may be readily computed.

The accompanying diagrams show the meter in operative relations to a working circuit, and under slightly modified arrangements.

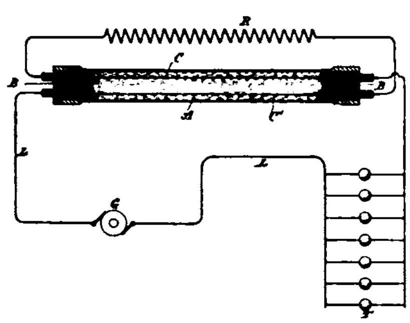


FIG. 1.—TESLA'S ELECTROLYTIC METER.

In Fig. 1, G designates a direct current generator. L L are the conductors of the circuit including lamps or other translating devices T. A is a glass tube, the ends of which are sealed by means of insulating plugs or caps B B. C C′ are two conductors extending through the tube A, their ends passing out through the plugs B to terminals. R is a resistance connected in series with the two conductors C C′, which by their free terminals are connected up in the circuit of one of the conductors L.

The method of using this device, and computing by its means the energy of the current, will be readily understood. First, the resistances of the two conductors C and C′, respectively, are accurately measured and noted. Then a known current is passed through the instrument for a given time, and by a second measurement the increase and diminution of the resistances of the two conductors respectively taken. From these data the constant is obtained, that is to say, for example, the increase of resistance of one conductor or the diminution of the resistance of the other per lamp-hour. These two measurements serve as a check, since the gain of one conductor should equal the loss of the other. A further check is afforded by measuring both wires in series with the resistance, in which case the resistance of the whole should remain constant.

In Fig. 2 the conductors C C′ are connected in parallel,

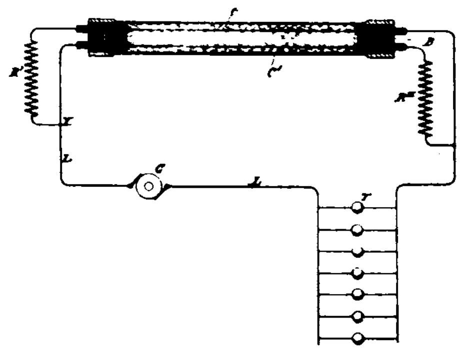


FIG. 2.—TESLA'S ELECTROLYTIC METER.

the current device at X passing in one branch first through a resistance R′ and then through conductor C, while in the other branch it passes first through conductor C′, and then through resistance R″. The resistances R′ R″ are equal, as also are the resistances of the conductors C C′. It will be observed that in the arrangement shown in Fig. 2 there is a constant potential difference between the two conductors C C′ throughout their entire length.

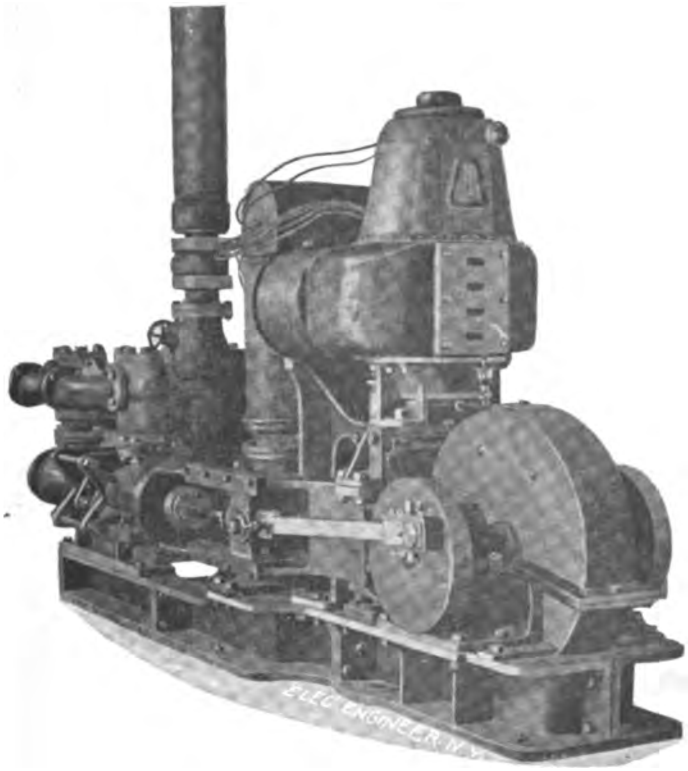
It will be seen that in both cases illustrated, the proportionality of the increase or decrease of resistance to the current strength will always be preserved, for what one conductor gains the other loses, and the resistances of the conductors C C′ are small as compared with the resistances in series with them. After each measurement or registration of a given variation of resistance in one or both conductors, the direction of the current should be changed or the instrument reversed, so that the deposit will be taken from the conductor which has gained and added to that which has lost. By this method it is possible to read off directly the amount of the energy expended by means of a properly-constructed ohm-meter, and without resorting to weighing the deposit; it is not necessary to employ shunts, for the whole of the current to be measured may be passed through the instrument; and the accuracy of the instrument, and correctness of the indications, are but slightly affected by changes in temperature. In addition to these advantages the arrangement possesses the merit of economy of energy, and simplicity in construction.

THE BERLIN ELECTRICITY WORKS.

THE work of constructing the stations of this company for the year 1890-91 is now finished. The stations in Markgrafenstrasse and Dorotheenstadt are completed, whilst in each of the two others the erection of two large machines will take place during this year. At the same time the distributing system in the inner portion of the town will be transformed into the three-wire system. The output of the stations at the end of the year is expected to reach 185,000 lamps. The number of consumers in 1885 was 28; in 1886, 146; 30th June, 1890, 862; 1st June this year, 1,310. The current supplied rose from 24,420,000 ampre hours in 1889, to 32,268,462 ampere hours in 1890.

THE EDISON ELECTRIC MINING PUMP.

One of the most important fields for the electric motor in mining work is that of pumping, and from the fact that electricity has already been very successfully used in or-



Edison Mine Sinking Pump.

dinary pump work, it is only fair to infer that in this newer class of operation its early promise will be fully justified, despite the severity of the conditions under which mining operations, where pumps are used, are generally carried on.

As an example of the manner in which electrical engigeers are attacking the subject, we illustrate on this page the combination that has been brought out by the Edison General Electric Co. of a 25 h. p. motor and a Blake double-acting pump, all on the same base-plate.

The motor is series wound, and designed to operate at 800 volts; it can be supplied, however, wound for any of the standard voltages. The field coils are divided into three sections, and the regulation of speed is effected by commutation of these sections by means of an ordinary car-controlling switch. The armature shaft is connected by a worm driving a large gear-wheel keyed to a pair of crank discs, one on each side of the machine. Wrist pins, placed at an angle of 90° with each other, carry the connecting rods operating the plungers of the double-cylinder pump, which is mounted on the same bed-plate with the motor. Each pair of plungers being connected together by outside rods, work together like one plunger, and the connection with the crank discs being at an angle, one pair of plungers is drawing while the other is forcing water, thus making them double-acting. The size of each cylinder is 5 inches diameter by 12 inches length. The following table gives the performance of this pump as obtained during a recent test.

The height given in the table below is the height of a column of water at 60° F., with the barometer at 30 inches, which could be supported by the given pressure per square inch. The actual height to which the given number of gallons per minute could be raised would depend on the length and diameter of pipe and the number of bends, and in any case would be less than its theoretical height.

Strokes Per Min.	Press. Lbs. per Sq. In.	Water delivered per Minute.		Elec. Energy Required. H. P.	Effective Work Done. H. P.	Commercial Efficiency.	Theoretical Height Water.
		Gals.	Lbs.				
56	0	0	0	8.04	0	0	0
38	25	155.04	1290	15.08	2.26	15	57.73
37	50	150.96	1256	15.08	4.4	29.8	115.46
35	75	143.8	1188	18.	6.25	34.7	173.19
31	100	126.5	1052	19.44	7.38	38.	230.92
30	125	122.4	1018	20.4	8.92	43.7	288.65
28	150	114.24	950	23.46	10.	42.6	346.38
26	175	106.08	883	26.27	10.83	41.2	404.11
24	200	97.92	815	28.15	11.42	40.57	461.84

Table Showing Result of a Test of the Edison Electric Mine Sinking Pump.

CUTTRISS' PROCESS OF INSULATING CONDUCTORS.

A novel method of insulating wires for electrical purposes has recently been devised by Mr. Charles Cuttriss, of this city. Instead of a sheathing made up of woven material consisting of seperate strands, or one in which a fibrous covering is associated with an insulating material which serves to bind the fibres to the core, Mr. Cuttriss proceeds as follows:

Cotton in the condition in which it leaves the carding-engine—that is to say, in the state of a delicate flat narrow strip or ribbon called a "sliver"—is coiled down into a can with its convolutions continuously crossing each other, so that when the sliver is removed its parts do not adhere to each other. This sliver is passed through boiling water and then drawn through a contracted nozzle or die, by means of which its fibres are slightly compacted and matted, and its tenacity considerably increased. While in this condition it is wound spirally around a wire, and by rubbing-plates is compressed or packed, and becomes felted or matted around the wire. This is wound on a spool or bobbin, and while the cotton is still moist, the spool is immersed in a bath of insulating compound, which is maintained at a high temperature until the air and moisture are driven out from the cotton sheathing, and the latter fully saturated with the compound. A sheathing made in this way and saturated with a compound composed, for example, of gum-copal or shellac and carbolic acid, or resin and resin-oil, will, it is claimed, insulate and protect a wire very perfectly, be flexible, dense, and durable, and hard and horn-like in character, without tendency to unravel or fray.

REACTING OR RECIPROCAL DRIVING AS APPLIED TO ELECTRIC PROPULSION.

BY

D. W. Mott

Early in 1879 I began to speculate, as inventors frequently do—positive in outgo, potentially negative in income—on a subject which has since gained, and will continue to gain, in importance,—in fact, stands to-day without a parallel in the industrial history of the world—that of electric traction as applied to the general subject of railway propulsion. The importance this subject has lately assumed in view of its possible adoption for the metropolitan rapid transit lines, warrants me in sending to you some of the results of my early labor in this particular direction, which may be suggestive in the evolution of this problem as well as interesting to some of your numerous readers.

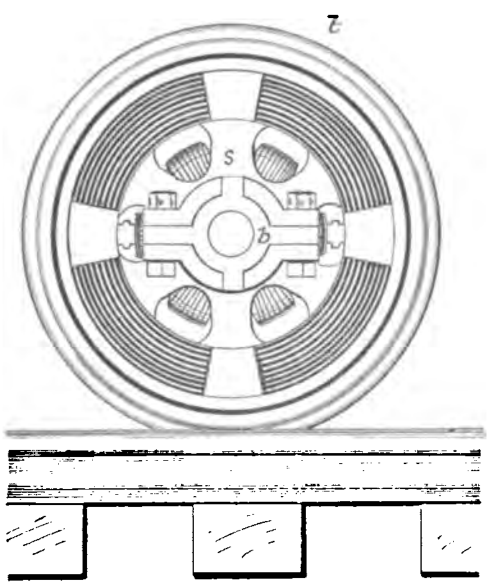


Fig. 1.

Up to the time mentioned I had never seen an induction motor, at least to know it as such, and was familiar only with the early forms of electromagnet motors, several of which I had access to at the time in the School of Science of Princeton College.

The making of each car unit self impelling, in other words distributing the power throughout the train, as distinguished from haulage, thereby securing the traction due to weight of train and dispensing with 30 to 60 tons dead weight of machinery, with the incidental advantage of many pulls or *multitorque* instead of one pull of a locomotive, was one of the early maxims I adopted in my work, and from present appearances it is fast becoming, if it is not already so, one of the axioms of electric traction. Among other minor features which I then incorporated in my plans, were inflexible coupling of cars, in order that the train would move as a unit, avoiding jerking or jamming when starting or stopping; distributing automatically the strength of current or motive power proportionally to each car according to the tonnage of each, whether it was loaded with passengers or freight, thereby avoiding the drag of one car on another and assisting to uniform movement throughout the whole; also the same feature with regard to magnetic brakes, they being supplied with power in proportion to the load, every train being controlled from one point, and each car capable of isolated and independent operation. I looked upon these general features at that time quite apart from

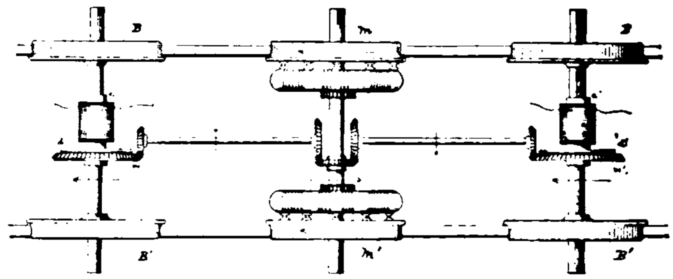


Fig. 2.

the comparative economy of electricity and steam as a motive agent, as affording one of the strongest arguments for its adoption, and I may say I have not since had cause to change that opinion.

I quite realized in 1879, as I do now, that the torque of a number of armatures without reduction to start a train from a position of rest under all conditions of load, was not in itself sufficient for the work, but did believe that it would suffice to keep up the motion after the car was started, and this led me, in 1880, to make drawings in which a simple mechanical arrangement of car starter played an important part in overcoming the *vis inertia* of the car, the motors being mounted upon one axle of each truck, and several other features convenient for the purpose working up the two in conjunction. The car was started and stopped mechanically, and electrically controlled while in motion.

In this same combination of motors applied directly to axle with car starters, I had also a form of epicyclic train for the reduction of speed, the same in principle as that illustrated in The Electrical Engineer of September 17, 1890, though different in arrangement.

The arrangement I worked out, though simple, I did not feel was the solution of the problem I was looking for. I thought there must be a way to multiply a small power into a great force for moving a car, in some way analogous to the simple lever, when great resistance or weight is to be overcome by the application of an insignificant force. I saw at once it was only a question of relative speed for a given time. There was plenty of speed, and to spare, but little pull. I wanted to reverse this, and was led to utilize the reaction in the motor, *i. e.*, to allow the two elements of the motor, the armature and the field, to revolve, and then, if I could bring this dual and reverse motion to bear at the same point, or at another point of traction through other axles or wheels, I would at once double the pull of a motor, and have twice the speed in the motor as at the point of traction; or in other words, *one* pound torque of armature would, on the principle of the simple lever, give *two* pounds pull to the car.

I then devised a number of mechanical methods of carrying this idea into practice, in some of which I used gears, in others no gears, and in either case was enabled to still further increase the statical or moving pull by the purely physical action of the current up to any degree of useful application. Of the several ways of carrying this reactive or reciprocal driving into effect, I will illustrate from my early drawings typical examples of each, (1) with gear, (2) without gear, (3) by cable. The accompanying illustrations come under the first head. There are three ways of motor mounting shown; the first, Fig. 1, is the electromotive wheel, where the motor is incorporated into, and forms part of, the supporting wheel of a car. This may have disadvantages in practice, depending upon the conditions and surroundings, but has this advantage under all circumstances, that the motive power adds practically nothing to the weight of the train, it being substituted for the ordinary wheel.

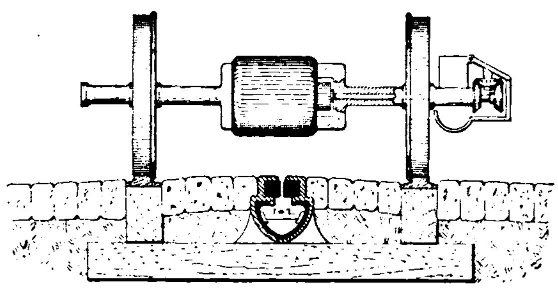
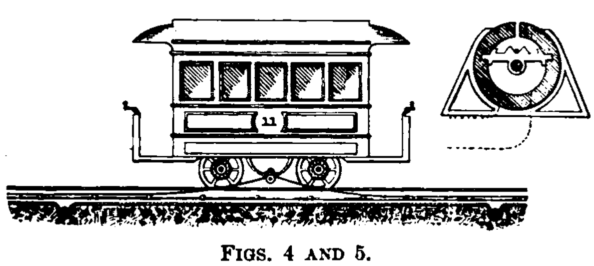


Fig. 3.

In Fig. 2 there are shown two motors on one axle but four or six drivers, as the case may be, the reciprocal action of the armature being communicated to the adjacent axle by the counter-shaft. Magnetic adhesion clutches are shown, which allow the armature free revolution; but these, it will be observed, are not necessary, and they were entirely done away with. The motor is of the multipolar type, with flattened ring armature of the Schuckert-Mordey type, mounted to an ordinary paper car wheel. The direction of motion of the several parts is indicated by arrows.

In Fig. 3 the motor is mounted at the centre of axle, the field magnet is hinged, and the armature mounted in such a way upon its shaft as to be readily dismantled. In this case, with the bevel wheels at the right and all of the same diameter, the speed between the armature and the field is twice that of the axle upon which the driving wheels are mounted, and the statical or moving pull of the motor is just double what it would be if mounted in the ordinary way. The armature shaft which runs through the driving axle is made subject to torsional elasticity to give the desired flexibility between the power and the point of its application, which idea is now in almost universal use in one form or another.

The street system of line and feeder shown in Figs. 3, 4 and 5 has, I believe, some meritorious points. The insulat-



Figs. 4 and 5.

ing conduit, Fig. 5, in which lie the feeder and working conductor, is made of concrete, cement, asphaltum, fire clay, etc. This conduit, it will be observed, may be nearly filled with water, and still preserve the insulation of line if properly put down; but of course it should be drained in the usual way. The supports of the working and feeding conductor act as braces to strengthen the conduit. The working conductor, made of silicon bronze or other material to resist abrasion, corrosion or oxidation, is lifted up through the slot to the trolley underneath the car as the car progresses, trailing back into the conduit as the car recedes. One car may be run faster than another and in either direction. There are no rigid sub-surface connections, but the drop conductor may be hauled around independent of the conduit, as at switching, etc.

Take the wheels out from car and replace by ordinary wheels, and we have the ordinary type of car. Throw the bevel wheels on the right, in Fig. 3, out of gear, and the field and armature will revolve together.

THE PITTSBURGH FIRE-ALARM SYSTEM.

About a year ago the Pittsburgh city councils gave the superintendent of the bureau of electricity permission to entirely refurnish the police and fire-alarm system, which at that time was in a totally antiquated and unfit condition. Mr. Morris Mead, the superintendent of that department, who had long been alive to the wants of his bureau, immediately set himself the task of giving the city the best system to be had, and has succeeded in designing one of the finest and most complete fire-alarm services in the United States. The accompanying illustration shows the interior of the office. The fittings are all of the best workmanship, and embody the latest improvements in this class of electrical apparatus. The cabinet work is of dark mahogany throughout, and tastefully hand carved. No less than 40 Breguet galvanometers indicate any defect or irregularity in the system, in addition to which a large upright galvanometer indicates the condition of the alarm circuits.

Central Office of the Pittsburgh Fire Alarm Service.

The annunciators, one for each signal circuit, are placed between the upper line of switches and the ornamental cap of the board, and are so constructed as to be restored by one movement, at the will of the operator, and the relays, furnished with rubber magnet covers and having platinum contact points, are mounted in compartments in sections of five, on marbleized slate bases.

All the work has been executed in the most workmanlike manner, under the personal superintendence of Mr. Mead, and was completed without any interference with, or interruption to, the working of the fire-alarm system.

PROJECTED ITALIAN ELECTRIC RAILWAY.

A scheme has been laid before the Italian Minister of Public Works for the construction of an electric railway from Aosta to Pré-Saint-Didier, that is to say, from Aosta to the Helvetian-French frontier. The project, which owes its origin to Signori Farrinet and Garrone, will, if carried out, bring into existence the largest electric railway in Europe. It is proposed to utilize local watercourses as the means of producing motive power

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Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed*, EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XII. NEW YORK, JULY 22, 1891. No. 168.

Not in a week, or a month, or a year, but by the lives of many souls, a beautiful thing is done.—Ruskin.

THE EDISON LAMP DECISION.

OUR readers have already received the Extra, in which, immediately after the handing down, we published Judge Wallace's decision in the great and important Edison lamp litigation. They know, therefore, that another of the critical campaigns in electrical warfare has been fought out, and that the future of one of the foremost electrical industries has been pretty clearly defined. At first reading, the decision in Mr. Edison's favor is not so very impressive, but the fact grows upon one with later perusal that it is fairly entitled to be called broad and sweeping. The patent is sustained, and it appears to control the situation.

There are a great many aspects to this long and costly litigation. It seems to us a matter for general congratulation that an electrical patent has once more been sustained. It may be said that Judge Wallace's decision will be promptly appealed. No doubt; but Judge Wallace's decisions have the reputation of being appeal-proof. If electrical patents of this fundamental nature were to be voided every time they came to the test, there would be a long farewell to advance in the electrical arts. Most of the stimulus to invention would be withdrawn; little inducement to capital would remain. Let us suppose, for example, that the Bell telephone patent, the Morse telegraph patent, the Brush storage battery patent, the Brush double arc lamp patent, the Edison incandescent lamp patent, had all gone down before the onslaught. Would there have been any material gain in the way of incentive to brains and money to become interested in new electrical ideas? None, but on the contrary, the feeling of confidence and permanence that lies at the bottom of all great industries would have died away, leaving little hope behind.

Next to inventors as a class, we may look at the inventor who in this case receives his reward. He certainly may be felicitated upon such an occasion, and if we judge him aright will value the vindication of his genius and his priority far more than he does the royalty that may come to him. Before and without Edison, there was no incandescent lamp; and while many aimed at the goal, it was his genius that turned failure into success, and gave to the world another of those beautiful, priceless things which, as Ruskin says truly, are the outcome of many years and many lives. If our readers would see how the work of Mr. Edison has been regarded by his friends, we would advise them to glance over the magnificent closing argument printed in our columns, of Mr. Grosvenor Lowrey, whom we may describe as the discoverer of Edison and his eloquent protagonist.

It is somewhat difficult to predict the immediate results of the decision in regard to the public and as affects electrical manufacturing interests. A great deal depends on the shape of the decree, which has not yet been entered. A great deal depends on the attitude of the Edison General Electric Co. A great deal depends on other inventors and their new departures. While there are accountings to be made, it is to be borne in mind that such a process is not one of the easiest or quickest things in the world. The game may be hardly worth the candle. Moreover, it is a notorious fact that while the Edison lamp business has been conspicuously successful, the industry as a whole has not been signalized by any great profit. Another peculiar feature is that for a time the patent upheld was actually in abeyance owing to the decision against it on the ground of foreign limitation; and during that period a great many lamp concerns started up which can plead good faith and immunity for at least that term. As to the attitude of the Edison General Co., we can only hope and believe that the corporation will exercise its victory with the moderation which is always the best proof of the right to power, and which will be only a further proof of the skill that has throughout been manifested in the direction of its affairs. Possibly the company, having spent so many hundreds of thousands of dollars to sustain its rights, may consider it necessary to "make an example." The phraseology of the decree will probably do much to determine its action. In some instances, there is really no change of conditions at all. For instance, the Thomson-Houston Co. has been paying royalty under the Sawyer-Man patents. It will be in practically as good a position should it simply pay that royalty into other coffers. In fact, we look for an interesting readjustment of relationships in the long run, with ultimate good to the whole electric lighting industry.

But as we have said, a great deal depends on that which is to be. Inevitably the drift of invention will now be towards the improvement of the incandescent lamp, and towards the introduction of forms that do not infringe. It is here that such work as Mr. Tesla's, so recently brought to notice, assumes a new and wonderful value. We mention Mr. Tesla, not because he stands alone as an innovator in this field, nor because he has altogether "arrived," but because his work is the most striking illustration of the possibilities that lie before us. Mr. Tesla gave us a motor without a commutator; and it would be strangely in keeping if he gave us now a lamp without a filament. Meanwhile the Edison Co. will enjoy the rich fruits of a great and hard-won victory.

Such, then, is the situation. While there are now probably few who will seriously deny that the modern system of incandescent electric lighting, one of the greatest achievements in the arts, originated in the world-renowned laboratory at Menlo Park, and while it may be admitted that, as a matter of abstract justice, the rewards and profits of the invention during the term of his patent, ought rightfully to fall to Mr. Edison, yet the fact should not be lost sight of, that even Judge Wallace was compelled to pronounce the specification of his patent a "perplexing" one, and to remark that it "leaves to be found by inference from generalities what the elements are of the combinations included in the extremely elastic terms of the two important claims." When we consider further, that for want of a vigorous and far-sighted executive, more than five years were permitted to elapse before the first step was taken by the old Edison Company towards obtaining a judicial determination of the meaning and scope of this patent, and that, as the law stood prior to the decision of the Supreme Court in the Bate case, the public were justified in the belief that the Edison patent must be held to have expired under the provision of the statute relating to prior foreign patents, a view in which Judge Wallace himself judicially concurred—when we consider all this it will be evident that the manufacturers of incandescent lamps who have invested large amounts of capital in their business, must in fairness be considered to stand in a far different position from that of wilful and inexcusable infringers. It would seem, therefore that, should the decision of Judge Wallace be affirmed by the Appellate Court, it might be an eminently wise and judicial policy on the part of the Edison Company to permit its competitors to continue in business, under an equitable royalty, at the same time fixing the minimum price of lamps to consumers at a remunerative figure, thus compelling future competition to be conducted on a basis of quality rather than of price. Such a course, while it could not fail to be exceedingly profitable to the Edison Company, would not only be less detrimental to the business interests of the community than a more arbitrary course, but would obviously be of direct and positive advantage to the true interests of the consumer.

THE WESTINGHOUSE REORGANIZATION.

With much pleasure we note that, as we ventured to predict last week, the Westinghouse reorganization has become an accomplished fact. This reorganization is the more striking for the reason that it was completed in full knowledge of Judge Wallace's decision upholding the Edison lamp patent; and the only inference possible is that the men of affairs and of leading who thus assume control by the investment of a large sum of money, are well satisfied as to the outlook. We are ourselves inclined to look upon the Westinghouse Company as now one of the most formidable in the field, and as being far more likely to-day to get business and do it profitably than it was in the time of its inflation and extravagance. It has stripped off superfluous burdens, and with obligations cut to the quick can market its product on a very favorable basis for securing good profits. We believe and hope that the company, and its rivals no less, has gone utterly beyond the "free lunch" period, of which the main idea has been that of doing business as a charity to the public, making goods for nothing and giving them away "gratis."

ELECTRIC HEATERS ON STEAM ROADS.

The problems connected with train lighting and heating are by no means few, and apparatus that has answered most of the requirements has been found to fall short in regard to others. The idea of using electricity for lighting is one that has been tried with varying results. While it has been a failure quite often, the actual data in successful instances is such as to promise that electrical methods will be predominant in the near future. This promise is greatly helped toward realization by the resort to electricity also for heat, on steam railroad cars, as some very cumbrous and delicate apparatus, piping, etc., is at once dispensed with, and the same attendant is every way competent to attend to both systems. We are very glad to note in our columns, this week, the fact that one of the largest and most influential steam roads has decided to adopt Burton electric heaters for some of its special first-class trains. This seems to us an event of the highest significance, and one of bright augury for the traveling public. The success of electric heaters in cars on electric railways has been notable, and this new work is simply an extension of present methods. The popularity of electric heating is young, but growing fast. We know of one instance where heaters have been ordered for a large block of apartment houses in a Western city. Evidently there are enormous advantages in a method that, using the same wires on which are placed the lights or fan motors of a house or office, furnishes also heat by the mere turning of another switch. In fact, with our changeable climate, a system that will thus give us cooling breezes one day and warm air the next, with kodak instantaneousness, is a great desideratum and boon.

THE MANUFACTURE OF OZONE.

The discovery of ozone by Schoenbein over 40 years ago was followed by a variety of experiments, and although it has been applied in isolated cases for commercial and sanitary purposes, no systematic attempt has thus far been made to reduce its manufacture to a commercial basis. We have therefore deemed it well to bring to the attention of our readers the efforts which are now being made in Germany towards this end; and a description of the apparatus given by Dr. Frölich, which appears in another column, will give a good idea of its simple character. The uses to which ozone can be put are quite numerous and the availability of high tension alternating currents has now placed us in a position to carry out practically the manufacture of ozone on a commercial scale.

Scientific Note Making.

WHILE a good memory is probably the best endowment for the student or worker in any field, the multiplicity of new ideas and inventions brought out by workers all over the world at the present day, makes it impossible for a single individual, however gifted, to keep in mind the facts which he may be called upon to employ at any time. It therefore becomes necessary to supplement the memory by some means, and thus relieve it of a strain which might in the end lead to serious results. The making of notes on such matters as one is likely to have occasion to refer to on subsequent occasions, therefore becomes an absolute necessity, and, for those who adopt a systematic course in this respect, the labor spent upon it will prove to be an excellent investment. In connection with this subject we desire again to call attention to the admirable index to electrical periodical literature which is now available, and which has been published since the beginning of 1887 and known as Fortschritte der Elektrotechnik. While not taking the place of an individual index such as every one must of necessity require for his own use, it places in the hands of the student the complete record of current electrical literature, and its value cannot be over-estimated. It will be noted that in our last issue, Mr. J. S. Brown published an admirable article showing how every man may get up just such an index for himself in his chosen lines of work.

Printing the Edison Lamp Decision.

IN keeping with its precedent in such matters, THE ELECTRICAL ENGINEER issued the Edison lamp decision immediately upon its handing down, on Tuesday last, in the shape of an Extra, and by Thursday afternoon had put forth some 10,000 copies of that document. The extra is paged so as to bind up in proper sequence with the other numbers of the paper, and we shall be glad to send a spare copy to any subscriber who may need another for that purpose. We are glad to know that our promptness in the matter and avoidance of delay of the regular current issue of the paper has been favorably regarded. One letter on the subject says: "Allow me to congratulate you on your enterprise. I remarked but yesterday that the case afforded an opportunity for one of the electrical papers to score a 'beat,' and I am glad you have appreciated the opportunity." THE ELECTRICAL ENGINEER has been the only paper to publish a report of the arguments of counsel in this case. It also printed the patent in full in its issue of June 10.

Electrolytic Meters.

THE simplicity of electrolytic forms of meters has always made them a favorite department of work with electricians, and though what may be termed motor meters have lately gained considerable ground, we nevertheless see continued efforts to improve those of the electrolytic type. As an example of this, we describe on another page a meter devised by Mr. Tesla, in which the indications are obtained by measuring the change in resistance of the electrodes due to the deposit of metal from one upon the other. This method adds one more to the available means for measurement of the electric current.

The Frankfort Electrical Congress.

THE interest which has been aroused by the Electrical Congress to be held in Frankfort next September is well shown by the list of papers already announced to be read, which will, no doubt, be considerably augmented as the day of the Congress approaches. This list, which will be found on another page, includes a wide range of subjects, and the papers will probably give rise to interesting discussion. Prof. Heinrich continues to give in his correspondence some very interesting glimpses of the exhibition itself.

Rights to be Respected.

IT is satisfactory to note that the Mayor of New York has been unable to wreck the Subway Company at his will. The Corporation Counsel informs him that he cannot seize their plant as he wished. It is a pity that similar restraint was not put upon Mr. Grant when he began his chopping down of wires and poles.

A ROUGH-AND-READY DYNAMOMETER FOR SMALL MOTORS.[1]

BY JOHN HOSKIN.

Mr. Hoskin began by explaining that the device he was about to describe was by no means new, but that it was deserving of more attention from electricians than it had apparently received. A rough-and-ready, portable dynamometer, inexpensive and readily used, is, he continued, much needed in cases where bulky and elaborate apparatus being alone available, the efficiency of small motors, etc., is very often left to guess-work.

The dynamometer described by Mr. William Warby Beaumont before the Institution of Civil Engineers of London Nov. 13, 1888, seems to fill this need.

Its construction requires only the use of a leather belt with a spring balance attached to one end and a suitable weight at the other. The belt is to be thrown over the belt pulley of the motor, the spring balance is fastened to the floor base or support of the motor to be tested, and the weighted end hangs pendant on the side of the pulley, which, when in motion, will tend to lift the weight. When the motor is at rest the strain of the weight should be read off on the spring balance. This reading we will call W. When the current is switched on and the motor runs at speed the spring balance should again be read off, since the friction of the pulley on the belt will have a tendency to raise the weight; this reading we will call W'. The difference between W and W' in pounds, multiplied by the circumference of the pulley in feet (including one-half the belt thickness on each side), and this by the number of pulley revolutions per minute, will give the foot-pounds of mechanical energy, which can be compared with the electrical energy required to produce it, in the usual manner. Thus, in a few minutes with the aid of a speed counter or tachometer, a voltmeter and an ammeter the efficiency of a motor can be determined, and its ability to do a desired amount of work ascertained at once.

The speaker then referred to the value of the Waldron rotary pump for use as a dynamometer. This pump is operated by rotary piston blades working in a chamber, without leakage, and with but small friction, the amount of which can readily be ascertained and calculated for use as a "constant." Its capacity per revolution and the number of revolutions being known, as also the pressure against which it works, which can be regulated by a pressure gauge, the foot-pounds of work are at once arrived at.

This method of measurement will correctly register the work done, although the speed may be irregular; and its results can be made more accurate than that of the friction dynamometer, because not subject to the irregularities arising from differences in lubricants, temperature, etc., which makes it necessary to use adjusting screws in most forms of friction-brake dynamometers.

1. Abstract of a paper read before the Electrical Section of the Franklin Institute.

THE COMMERCIAL MANUFACTURE OF OZONE.[1]

BY DR. O. FRÖLICH.

THE generation of ozone by electricity, as well as a large number of its interesting reactions are well known, but the introduction of ozone for commercial purposes has not yet been undertaken on account of the lack of suitable apparatus for generating it in large quantities. The best method of generating ozone electrically, as is well known, is by means of the silent discharge, and as early as 1857 W. von Siemens designed his well-known ozone tube, which is still in use in laboratories.

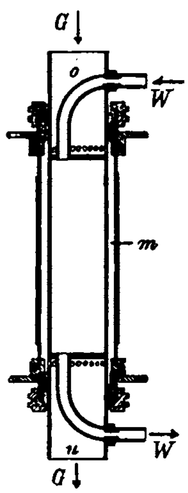


FIG. 1.

The same idea has been embodied in the apparatus recently designed at the works of Siemens & Halske, of Berlin, for commercial purposes, and its construction is shown in the accompanying engraving Fig. 1. As will be seen, it consists of an inner metal tube which is surrounded by an outer one forming the dielectric tube. The top and the bottom of the metal tube are closed, and the space between these two covers is filled with cooling water kept in circulation by tubes W W., reading from the top and bottom. Above the top and below the lower covers there are rows of holes through which the gas to be treated G is drawn from the upper space *o* into the space *m* between the dielectric cylinder wall and the inner metal tube. From there it passes to the lower end *u*, and out. The dielectric cylinder is made of hard rubber or celluloid, and leather rings serve to connect the parts.

Fig. 2 shows a set of these tubes as arranged for commercial work. The apparatus is so arranged that the cooling water passes through all the tubes, and so that a tube in case of rupture can be readily replaced.

The author has employed continuous currents, interrupted by a special rotating commutator at a rate of 600 per second. By this means far more ozone is generated than with an alternating current machine and induction coil, having only 50 to 100 reversals per second. However, when the number of ozone tubes is increased, this relationship is reversed and the alternating current exceeds in efficiency the continuous interrupted current. Further investigation seems to show that the generation of ozone is largely dependent upon the nature of the alternating current and that the steeper the curve, the more efficient it is. The generation also depends upon the mean E. M. F. in the tube; thus, up to 4,000 volts, using a glass tube, no ozone is generated. With increase of potential, other things being equal, the generation increases rapidly until finally the tube bursts, so that care must be taken not to exceed a certain limit. It was also determined that transformers with open magnetic cores as in the ordinary Ruhmkorff coil are more efficient than those with closed magnetic cores. Experiments have shown that with 2 horse-power, 2.4 milligrammes of ozone per second can be produced.

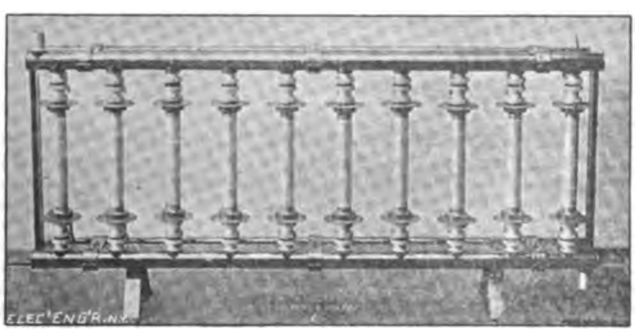


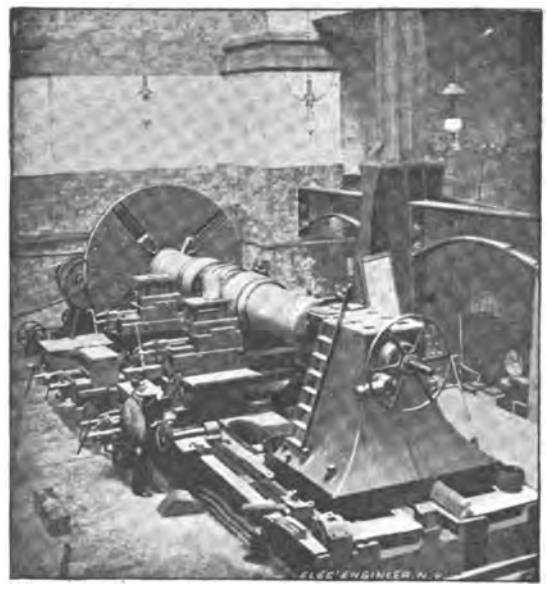
FIG. 2.

Among the many applications to which ozone lends itself, the author mentions particularly the disinfecting and sterilizing of water, there being good reason for assuming that the worst natural water can be made potable by ozonizing. He also refers to its application in bleaching processes and in the curing of wines, and, generally, for disinfecting purposes, its action on all bacteria and small insect life being very destructive.

1. Abstract of a paper read before the Elektrotechnische Verein of Berlin.

MONSTER LATHE AND SHAFT AT THE FERRANTI DEPTFORD STATION IN LONDON.

OUR readers have already been informed of the remarkable character of the electrical engineering undertaken by Mr. Ferranti at the Deptford Station in London. There are already in operation there two engines of 1,500 h. p. each, but the station is arranged for additional engines of far greater capacity, and there are now in course of construction two units with an ultimate capacity of 10,000 h. p. each. These enormous dynamos are of special construction, and the design chosen by Mr. Ferranti embodied a shaft no less than three feet in diameter. As no engine building firm would undertake the complete manufacture of such a shaft, Mr. Ferranti boldly set about to build a lathe specially for that purpose, and the accompanying engraving, made from a photograph placed at our disposal by Mr. John Van Vleck, chief engineer and electrician of the Edison Electric Illuminating Co. of New York, gives a good idea of the enormous proportions of this tool. The engines will be compound, with cylinders 44 and 88 inches in diameter and 6 feet 6 inches stroke. The moving parts of each generating unit, including the armature, will weigh 225 tons, and when finished will, without question, be by far the largest electric generating unit in existence. We may add that Mr. Ferranti, notwithstanding the criticisms which were made upon his work in the beginning, is fully satisfied that the course adopted by him was the correct one, and that the general tendency to larger and larger units bears out the truth of his early arguments.

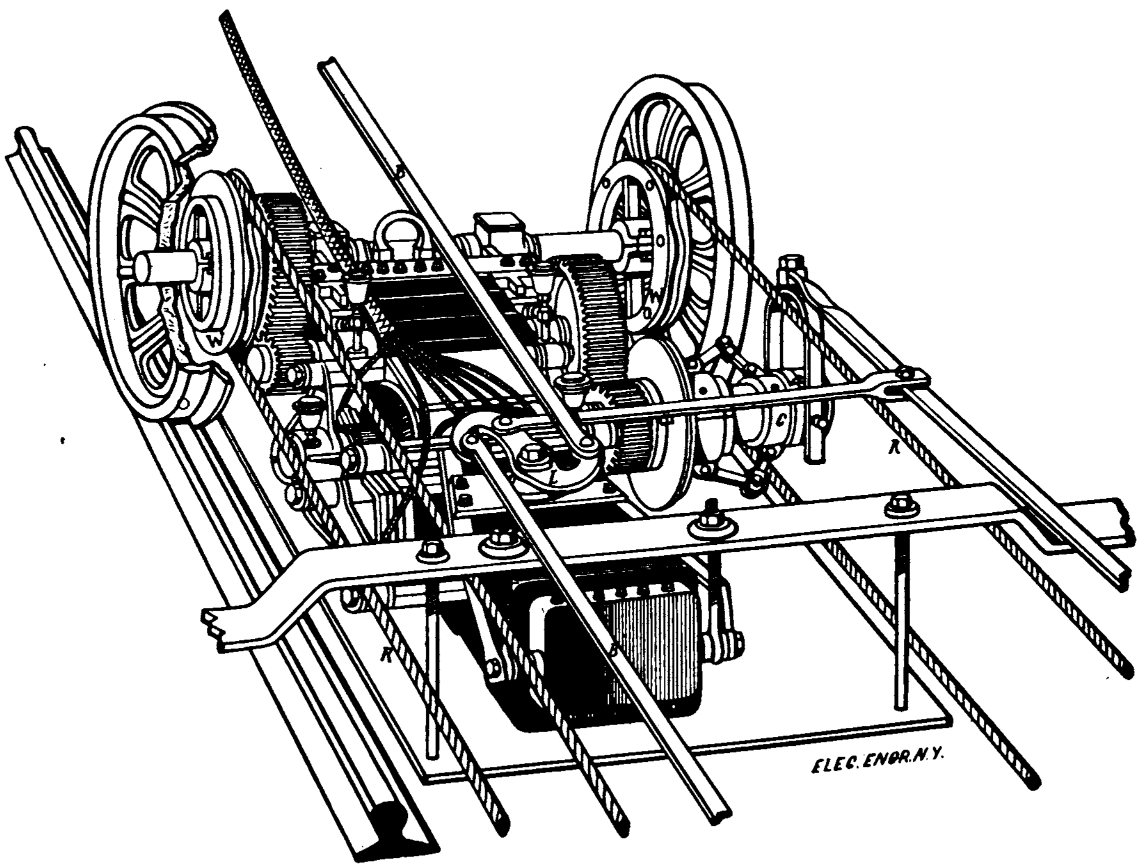


LATHE AT THE FERRANTI DEPTFORD STATION, LONDON.

THE WINKLER ELECTRIC CAR GEAR.

In a recent issue we had occasion to describe a novel type of dynamo, designed by Mr. C. F. Winkler, of Troy, N. Y., and this week we are enabled to place before our readers an ingenious method of operating electric cars invented by Mr. Winkler. Recognizing the losses due to the heavy draught of current taken by the motor when starting from dead rest, Mr. Winkler has started out with the idea of maintaining the motor on the car in continuous operation and throwing it in gear with the driving axle when starting, thus avoiding the heavy rush of current, and at the same time utilizing the momentum of the armature for starting. He has also devised an ingenious method of driving both axles from a single motor, which will be clearly understood by a glance at the accompanying engraving.

The motor which revolves continuously, is thrown in and out of gear by means of the levers B, which are connected to either platform of the car, and acting through the link L, throw in or out, the clutch C, which connects the armature shaft with the driving gear. Mounted on both axles are a pair of pulleys which are connected by means of the rope gearing R. The grooves on these pulley wheels W, however, it will be noted, instead of being straight, have a gentle sinuous curvature. The wire rope takes this curve and hence is enabled to exert a practically unlimited pull without slipping; the arrangement being somewhat after the nature of the well-known form of cable grip. In the experiments made with this car, it was shown that the car could be readily started with the momentum of the armature alone by shutting off the current and operating the clutch. The car has been in experimental operation on the Troy and Lansingburgh Electric Railway.



Truck Equipped with the Winkler Electric Car Gear.

THE GREATHEAD SYSTEM IN LONDON.

The project of building a deep tunnel railway on the Greathead system from Bayswater to the City, about an equivalent for the distance from Harlem to the Post Office in New York, seemed threatened, says the London correspondent of the New York *Times*, with a lot of opposition, but on examination this has shrunk to such proportions that a committee of the Lords has passed the bill without a single restrictive clause. The Commons committee has also passed the scheme for a Greathead tunnel under the Forth to run close to the Forth Bridge and to be utilized in connection with railway traffic over the bridge. The issue of these schemes has been watched with much interest, and their success establishes the system as the popular English solution of the rapid-transit problem.

MR. PREECE ON ELECTRIC LIGHTING AND GAS.

Mr. W. H. Preece (chief electrician to the G. P. O.) delivered recently, says our London correspondent, a very interesting and popular address before the Incorporated Association of Municipal and County Engineers, at the Institution of Civil Engineers in London. Addressing the members rather as a gas shareholder than as an enthusiastic electrician, he said the questions they had to decide were principally such questions as the following: What was the capital involved in a particular industry, what was the profit derived, and what had the consumer to pay? He was not going to put before them any fanciful figures, but figures which were published and which any one could check. In Manchester a ton of coal produced 9,611 cubic feet of 20 c. p. gas—rather in excess of the average of the country, which was not more than 15 c. p. From this it followed that in Manchester 1 lb. of coal would produce 4.29 cubic feet of gas, and if 4.29 cubic feet of gas were burnt per hour it gave an illuminating power of 17.2 candles. On the other hand, 1 lb. of coal burnt in a boiler to produce steam would give in electrical energy in the form of a glow lamp, such as was used in houses, 48 candles, and in an arc lamp, such as was used for street lighting, 288 candles. So that they started with the fact that 1 lb. of coal distilled into gas in Manchester gave a light of 17.2 c. p., and 1 lb. of coal converted into electrical energy would give 48 candles with a glow light and 288 candles with an arc light. In Manchester, during the twelve months ended March 30th, 1890, the income derived from gas was £434,851, and the expenditure was £360,804, showing that a balance of just a little over £73,000 was derived from gas, which was devoted to paying interest on loans, depreciation and cost of public lighting. The cost to the corporation of Manchester now of producing light equal to 4,000 candles by gas was 2s., and having obtained a provisional order to enable them to erect a central electrical-generating station, the corporation were now considering whether they should carry it out themselves or transfer it to another body. As to the cost of electricity, there was now more reliable and truthful information than there were, perhaps, as to anything else connected with electricity, and from figures in the possession of the Board of Trade, who had such a powerful control over the electric lighting interest that there could be no "shuffling" with their accounts, there was not a shadow of doubt that at the present moment the "Kilo-Watt," which was the Board of Trade unit of electrical energy, could be produced for 4d., which meant that as against 4,000 candles of light produced by gas for 2s., 4,000 candles could be produced by electricity in the form of the arc light for 8d. and in the form of the glow lamp for 4s. Having shown that what was nominally 15 candle gas was reduced to 10 by reason of dirt in the burner, draughts and the flickering of the light prevented the combustion of the gas, and that gas was wasted by being left flaring unnecessarily, Mr. Preece proceeded to argue that there would be no such waste with electricity. Taking the figures of the nine chief towns of England, he showed that the average price paid by the consumer for gas per light per annum was 9s. as against 10s. for electric light, calculated on the 200,000 lamps at present in use in London. Those were rather startling figures, as most people were under the impression that the cost of electric lighting was very much more than that of gas, and he was very much surprised to find that in his own house, where for the last eight years he had had an engine and accumulators and generated his own electricity, the price he paid for his lights amounted to less than 10s. per lamp per annum. He had had tabulated the revenue derived by each of the London electric lighting companies per 33 wall lamps by which it appeared that the Metropolitan derived a revenue of 12s. per lamp; the Chelsea, 8s. 6d.; the Kensington and Knightsbridge, 9s. 2d.; the House to House, 11s. 6d.; the St. James' and Pall Mall, 9s. 6d., and a company in Brighton derived an average revenue of 8s. 6d.—the mean revenue for 200,000 lamps in London being 10s. In Manchester, where gas was cheaper than in London, the average price paid per lamp per annum was 7s. 6d. as against 8s. 4d. for the electric light. In London the Electrical Supplies were charging 7½d. in some instances and 8d. in others. In Bradford they commenced by charging 5d., but they had now raised the price to 6d. In Newcastle-upon-Tyne they were charging the public 4½d. and allowing considerable discounts on that 4½d. to large users of electricity. In the case of the post office at Newcastle, for instance, there had been a discount of 20 per cent., so that in that town the cost of electric lighting very nearly approached the price of gas. In Bolton, at Messrs. Horrocks' mill, which had for the last six years been lighted by electricity, the cost worked out at 4s. ½d. per lamp as against 5s. 6¾d. when they used gas. In Manchester, again, there was under the Exchange a very large restaurant which used to be unbearable when lighted by gas, but with the electric light now the manager found that he was not only saving £800 a year in the cost of illumination, but that his business had doubled by reason of the atmosphere being cleared so that people were able to eat their meals in comfort. When the association visited the Royal Naval Exhibition they would see that the electrical energy used for the whole exhibition was generated by one engine and one dynamo coupled together. At Deptford they would find space for electrical machinery sufficient to light a million lamps, although at the present moment only about 200,000 were kept going. One of the greatest merits of electric machinery over gas machinery was the small space that was occupied by the former. Whilst a space of 100 ft. by 50 ft. was required for the machinery necessary to manufacture a million cubic feet of gas, the same space would contain electrical machinery sufficient to light up the whole of a big town. The adoption of the electric light in houses would remove a source of deterioration to goods and chattels, to one's books and pictures, and it would do away with that which destroyed decorations and dirtied ceilings and would introduce something which encouraged cleanliness, and which would add materially to one's comfort and cheerfulness. Nothing would add so much to the cheerfulness of this life as the electric light, and he felt quite satisfied himself that if he had not had the electric light in his house for the last eight years he would not have been addressing the association at that moment. The chief controller of the post office told him that on Christmas Eve the electric light had enabled them to get through the work quicker than they had ever done before, and that it was equal to 200 men. In the savings bank department of the post office the cost of the electric light had been paid for by the increased service that was got out of the staff there. It had diminished the number of hours of absence by two hours per head per annum; and that put at 10d. per hour, the ordinary overtime rate in the Government service, amounted to a saving of £680 a year, and as the cost of the electric light was £700, it really amounted to £20 a year out. It was argued by many in England that electric light was only for the rich. He wanted them as engineers to persuade the corporations they represented to look to the introduction of the electric light so that it might become the light of the poor.

New Type-Setting Machine Operated by Electricity.—Mr. C. L. Redfield, of Chicago, has invented a new form of type-setting machine, which is claimed to have remarkable features of practicability and simplicity. The power for making an impression with the type is furnished by an electric motor. The impression is made by the type on card-board, especially prepared for this purpose, which costs a trifle more than ordinary paper. The impression on the card-board leaves a matrix ready for pouring in the electrotype composition to form the plate. The machine on actual test was shown to do work equivalent to ten ordinary compositors. The company controlling the invention is the Chicago Matrix Machine Co., E. B. Springer, president; P. H. Gunckel, vice-president; William Tuckington, secretary and treasurer.

Literature.

Histoire d'un Inventeur. A Record of the Discoveries and Work of G. Trouvé in the Domain of Electricity. By Georges Barral. Paris, 1891. *Georges Carré*. 610 pp., 6½ x 10 inches.

There is probably no name better known among electrical workers, and amateurs especially, than that of Gustave Trouvé, and if we take into consideration the enormous number of ingenious devices and inventions due to this electro-mechanician, his celebrity is not to be wondered at. There is hardly a branch of applied electricity which Mr. Trouvé has not taken up and in which he has not done some good work. The history of such a man, as well as the complete record of his work, cannot fail not only to interest the reader, but to go far towards instructing him in various methods of applying the better-known phenomena of electricity.

Mr. Trouvé was born at La Haye-Descartes in the Arrondissement of Losches in the department of Indre-et-Loire on the 1st of January, 1839. From his early youth he showed great aptitude for mechanical work and delighted his playmates by his skill in making toys. One of his very first machines was a small steam engine driving a trip-hammer, which he built when he was only seven years of age, and which was constructed entirely of wood, lead, and tin. These were followed by other inventions of a mechanical nature, but very soon Mr. Trouvé was fascinated by the possibilities of electricity and from that time on devoted most of his attention to work in that department. It would take us too far to mention even the principal and most important apparatus devised by Mr. Trouvé and admirably described and illustrated in the work before us, but, as we have said before, there is hardly a branch of electrical work which Mr. Trouvé has not gone into and which has not been enriched by the product of his brain and hand.

The practical electrician, no less than the electrical amateur, will find this work not only instructive, but highly entertaining. It is profusely illustrated and contains an admirable index, not only of the contents of the book, but of the original publications in which all of Mr. Trouvé's inventions have appeared.

Appointments, Etc.

Mr. E. D. A. Brady, of New York City, who has been an agent of the Gamewell Fire-Alarm Tel. Co., has been appointed electrical engineer of the Frackville & Gilberton Electric Light, Heat and Power Co., of Frackville, Pa., which is going to install an extensive plant.

Mr. N. S. Possons, formerly superintendent of the Brush Electric Co., has become the general sales agent of the Eureka Tempered Copper Co. from July 1st. His large experience in electrical and mechanical matters will make him a very valuable acquisition.

Mr. E. W. Dutton, who has had charge of the Thomson-Houston electric light plant at Atlanta, Ga., has become master mechanic of the Atlanta consolidated electric railway lines, with charge of repairs, new construction and all mechanical work.

Mr. John Protzman, electrician of the electric light company at Streator, Ill., has gone to Bessemer, Ala., to take charge of a large plant started there by Mr. E. J. Stiles, of the former city.

Mr. W. G. Meloon, who has installed a great many Thomson-Houston plants, has accepted a position with the Thomson-Houston Co. at Cincinnati.

Mr. O. E. Rundahl, late of the Hutchinson, Kansas, Water, Light & Power Co., has taken charge of the electric light plant at Cañon City, Col.

Mr. M. W. Thayer has resigned from the charge of the electric light plant at Winchendon, Mass., and has been succeeded by Mr. Skerry.

Mr. Frank T. Robinson has been chosen general manager and treasurer of the Johnson Electric Train Signal Co., of Woburn, Mass.

Mr. A. J. Martin has been appointed the manager of the West End Electric Co., of Philadelphia, which has lately put in a large plant.

IT "FAR EXCELS."

A correspondent at Carthage, Mo., writes us:—"I received a sample copy of The Electrical Engineer last December from our local news agent. I had been taking several other publications but quit them, and now have The Engineer from Jan. 1 up to this week's number. I think it far excels all the rest in illustrations and in the descriptions, which are the life of any scientific paper."

Society and Club Notes.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

The Citizens' Committee of Montreal are pushing forward the completion of their plans for the entertainment of the National Electric Light Association with the vigor for which the good people of that city are so noted. The corporation of the city has just voted the appropriation of a large sum of money, to be placed at the disposal of the Citizens' Committee.

The use of quite a number of yachts has been tendered by private gentlemen of Montreal especially for the pleasure of the ladies attending.

President C. R. Huntley, of the Association, informs us that a new feature will be introduced this year, as suggested by the Executive Committee, which will add to the interest and the diffusion of practical information on the details of work in connection with the operating of central station and other plants. A "Question Box" will be placed at headquarters in Montreal for the reception of written questions upon any pertinent subject. This box will be opened prior to each session, the questions read in open convention, and answers requested from those who are willing to speak upon the subject. This plan will, no doubt, be very favorably received, and will give excellent practical results.

College Notes.

THE OHIO STATE UNIVERSITY.

An advertisement in another column calls attention to this excellent institution. The State has adopted a policy of just liberality toward it, and it is advancing rapidly to a place among universities of the first rank. The range of instruction includes courses in arts, philosophy, modern languages, science, and agriculture; in civil, mechnical, electrical and mining engineering; and in veterinary medicine and pharmacy. Two new buildings are to be erected the coming year. Three new departments have just been created, and two more professors in agriculture and botany are soon to be added, making the total number of teachers forty-five. It seems certain that Ohio is at last to have a university of ample resources and facilities.

It will be well for all interested in securing a good training for students in electrical engineering to send for the large and instructive catalogue issued free by this popular school, located at Columbus, Ohio.

JOHNS HOPKINS UNIVERSITY.

MR. HERMANN S. HERING, who has for the past five years been professor of electrical and mechanical engineering at the Manual Training School of Philadelphia, has just been appointed to the position of associate in electrical engineering at Johns Hopkins University, in Baltimore, where he will begin his duties in October, associated with Dr. Louis Duncan. In his former position Mr. Hering originated the course in the Manual School, and made it a very creditable one, especially so considering the extremely limited resources of the school in apparatus and laboratory room.

PRATT INSTITUTE, BROOKLYN, N. Y.

A few months ago we published an article by Mr. A. C. Boughton on the electrical work doing at the Pratt Institute. The catalogue just received shows that the electrical course is being maintained and developed on excellent lines. The course is in charge of the Department of Mechanic Arts, of which Prof. C. R. Richard, is director, while Mr. F. W. Dunbar, B. S., is the instructor in electrical construction.

UNIVERSITY OF PENNSYLVANIA.

The university has announced its decision to increase the time given to mechanical and electrical engineering by providing additional courses on these subjects, extending over four years. Examinations for admission will be held September 21. Full information can be obtained from the dean of the college department or from the professor of mechanical engineering at the university.

UNIVERSITY OF MINNESOTA.

Mr. George B. Shepardson, late instructor in the electrical laboratory at Cornell, has resigned his position to take charge of the new department of electrical engineering at the University of Minnesota.

Reports of Companies.

SUCCESSFUL REORGANIZATION OF THE WESTINGHOUSE CO.

At a meeting of the stockholders of the Westinghouse Electric Company on July 15, it was unanimously decided to accept the plan of reorganization recently proposed.

The following new board of directors was elected: Charles Francis Adams, Boston; Lemuel Bannister, Pittsburgh; August Belmont, New York; A. M. Byers, Pittsburgh; Charles Fairchild, New York; Marcellus Hartley, New York; George W. Hebard, New York; Henry B. Hyde, New York; Brayton Ives, New York; George Westinghouse, Jr., Pittsburgh.

By the plan of reorganization adopted $4,000,000 of 7 per cent. cumulative preferred stock is created, of which $3,000,000 has been taken at par by the reorganization syndicate to care for the company's floating debt and provide additional capital.

The assenting stockholders give up 40 per cent. of their stock, aggregating over $2,500,000, par value, for the use of the company, and are given upon the 60 per cent. of stock which they retain a 7 per cent. preference over the very small amount of non-assenting stock remaining out. The company is doing a large, progressive and profitable business, and bids fair to become a more formidable competitor than ever in the electrical field.

UNITED ELECTRIC SECURITIES CO.

The United Electric Securities Company, of Boston, invite proposals for sale to the company of $50,000 first series collateral trust sinking fund 5 per cent. bonds. This call is in addition to previously issued call for $30,000 first series and $20,000 second series bonds.

DIVIDENDS.

THE SOUTHERN NEW ENGLAND TELEPHONE CO. have declared a dividend of 1 per cent. payable to stockholders of July 16. The capital is $1,500,000. This is the first dividend in over two years, but the company hope to pay 1 per cent. quarterly from this time out.

MIDDLETOWN, CONN. The Middletown Electric Light Co. has declared a semi-annual dividend of 2 per cent. in spite of the damage done by the ice storm, amounting to $1,000. The old officers have been re-elected.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of July 18, 1891, from New York, Boston and Washington:

NEW YORK.

	BID.		BID.
W. U. Tel. Co.	79⅜	Edison Gen. Elec. Co.	101
American Tele. & Cable	79	Edison Gen. Co. Def'd	....
Centl. & So. Amer.	130	Consol'd Elec. Lt. Co.	...
Mexican	200	Edison Illu'g Co. N. Y.	79
Com. Cable Co.	104	U. S. Elec. Lt. Co.	30
Postal Tel. Cable	23	North Am. Phonograph	...

BOSTON.

	BID.		BID.
Thomson-Houston	40	Ft. Wayne Co.	11⅞
" Pref'd	....	Am. Bell	....
" Series C	....	Erie	48
" " D	7	New England	50
" Int. Co.	....	Mexican	1.17½
Thomson Welding Co.	....	Trop. American	80
Thomson Eu. Welding	....	Edison Phon'gph Doll	....

WASHINGTON.

	BID.		BID.
Penna. Telephone	24	U. S. Elec. Lt (Wash.)	155
Ches. & Pot. Telephone	62	Eck. & Sold. Home Elec. Ry.	49¼
Amer. Graphophone	5⅜	Ge'rget'wn & Tennallyt'wn	57

PITTSBURGH.

Westinghouse El. & Mfg. Co. .... |

Legal Notes.

EDISON INCANDESCENT LAMP LITIGATION.—VI.

ARGUMENT OF GROSVENOR P. LOWREY, ESQ., (CONCLUDED).

Mr. Lowrey said he would pass the parliamentary investigation, only reading what had been said by Tyndall and by Sir William Thomson. Professor Tyndall must have been supposed to have known all that anybody knew of the King lamp, but nevertheless he did not think incandescence was worth while in respect to lighting in small centres—he did not think there was much in it. Mr. Conrad Cooke, editor of *Engineering*, in speaking of Edison, had said, "His nephew told me himself that he has seen over 200 lights in one circuit. I must say that I should like to see it myself." Then Sir William Thomson; that great authority, that really wise man, the sort of man who probably did not understand Ohm's law; who, if you had asked him, would probably have said he once thought he did, but was finding out so much every day he was not sure now, had said: "It is quite possible that a plan of using electrical energy for light may yet be found, in which ten feebler lights will give a sum equal to that obtainable by the same energy in one concentrated light." That had not been found. Edison did not find, nor did any one ever find, that one could divide that lamp of 1,000 candles into ten and retain the total of 1,000. What Edison had done was to find that it could be divided and get ten lights of ten candles each, in ten places where they were wanted, and find a money-making business in supplying them. It had not occurred to Sir William Thomson that there were several ways of getting around a stump; that way had to be found out from this practical fellow at Menlo Park, who was so ignorant. He (Mr. Lowrey,) had often thought what an awful thing it would have been for the world, if Thomas A. Edison had the misfortune to be educated at Stevens Institute. Then he would have known, as they all knew, the mathematics, and then he would have known too, what things could not be done. There was reason to be grateful that it was not everybody to whom the fortune of a liberal education came, because in this business of investigating nature, a liberal education often enslaved the mind. There was Professor Elihu Thomson; he understood him to be of the opinion that it had been a mere matter of electrical engineering to make this lamp; all the required laws were known and the rest was mere ciphering. Now Prof. Thomson was an expert cipherer; he was a professor in Pennsylvania; an inventor; a man of excellent ability, he had been engaged in the search after a small light before Edison began, but it had never once occurred to him to sum up all these outstanding unused laws, which he knew so much about, and evolve the light before us.

All this time they had had Mr. Edison underground looking for this thing; he had sent up from time to time various little things he had hit upon, by way of indicating what progress he was making. Various discoveries had been made, patents had been sent to the upper ground, and in all of them high resistance had been insisted on. Mr. Edison in his testimony had said:

What we desired at that date [November or December 1878] and had concluded as the only possible subdivision of the electric light was, that the lamps have a high resistance and small radiating surface, so as to be capable of being worked in multiple arc commercially; and our calculations showed us that the lamps must have at least 100 ohms resistance to compete successfully with gas; otherwise if the lamps were of low resistance the cost of main conductors would be so great as to render the system uncommercial.

Mr. Lowrey said that the latter part of this quotation seemed to be a great comfort to his friends on the other side. There might be something else requiring his attention, but he believed the 100 ohms was now their sheet anchor. Mr. Edison had frequently used the term "calculation." Evidently General Duncan supposed that he had meant that the mathematicians had made calculations and now he was going to fix Edison with the responsibility. But Edison saw what it meant and he said: "I don't mean that I made figures; I don't mean that I made calculations"—and with a sudden burst of scorn—"I find the mathematicians are always wrong." Mr. Edison had there given expression to what he (Mr. Lowrey) believed to be perfectly true statement, as to the intuitive way of genius in ascertaining these things. In dealing with a subject like this, when Edison saw the elements which composed it, the mathematical results were instantly before him, not in figures nor on paper, but he realized the whole thing, and he sent the mathematicians back to figure things over again to prove his intuitions. It was then that Edison had come to Ohm's law. He had been called down from his laboratory,—where he had been no doubt at work on things interesting to himself—and had been asked questions until he thought he had answered all that could be fairly asked, and then came this notable answer about Ohm's law.

Mr. Edison had first taken up platinum for the reason that carbon under the old conditions was not good; his first utterance on the subject had been a lament that carbon would not serve, because of its known tendency to unite with oxygen in a state of incandescence; so he had turned his attention to platinum, and he (Mr. Lowrey) could conceive that he had done it with a longing eye cast back all the time towards carbon. Mr. Batchelor had said that he would say: "Oh, Batch! if carbon could only be made stable!"—stable under the stress of high incandescence, and when used in quantity necessary to give high resistance and small radiating surface; so he had taken up platinum. His Honor would perceive the trouble which the inventor had been put to to overcome the evil tendencies of platinum. He had been compelled to provide an air chamber and a thermo-regulator to prevent overheating by automatically shutting off the current.

When Mr. Edison had returned with his lamp in his hand from his investigation of the foundations of this recondite subject, he had been met with various kinds of greetings, which were valuable, as showing what science had then thought about what he had professed to have discovered. Without stopping to read these, Mr. Lowrey said, he would call his Honor's attention to a published interview from which his Honor would find that Prof. Morton thought very little of the little carbon. He says that what Edison had to do was to find out whether it would last; that was exactly what Edison had been finding out. He had found disintegration to be the result of high incandescence, until it had been protected in that high vacuum which nobody before had tried. Mr. Sawyer too, after the publication of Edison's discovery, had offered to bet large sums of money that the little carbon would not last twenty minutes in a proper vacuum.

Turning to another branch of the case, Mr. Lowrey said that there were remaining certain very pertinent questions relating to the construction of the patent, as well as certain questions of law affecting the state of the art and its influence, under the special facts of the case, upon the rights of this inventor. The defendants appeared to be making three defences to the first two claims of the patent; *first*, that both claims were void, because it was no invention to substitute superior for inferior materials in making one or more, or all of the parts of a thing; *second*, that those claims were further void for want of invention, because it was not invention to change the degree of a thing, or one feature of a thing; *third*, that in the light of the state of the art and of the descriptive part of the specification, the claims must be so construed as that the defendants did not infringe.

In searching for the nearest approaches in the prior art two fields must be explored; the prior plans for illumination by carbon burners and those by platinum burners. The defendants had contended that the Adams lamp was to be found in the first field, and if so, it constituted the nearest approach to the invention of the patent. For the purposes of the argument they might consider that it was an abandoned invention, and not merely an abandoned experiment. In the second field of the prior art defendant had contended that Edison's platinum lamp was to be found; if so, it undoubtedly constituted the nearest approach from that side, to the invention of the patent. The complainant contended that this was not a part of the prior art, but for the purpose of the argument they might assume for the present that it was. Mr. Wetmore had argued that it was a part of the prior art; *first*, because the American patent, though not granted until after the patent in suit, ranked in point of priority as of the date of its prior application, April 21, 1879, and *second*, because the French patent of June, 1879, though granted to Edison himself, as truly constitutes a part of the state of the art as if it had been granted to a stranger. The complainants denied both these propositions of law. Mr. Lowrey then cited authorities in support of the proposition that it was well established, where a patent is sought to be used as a club to defeat another patent, that it dates as to the date of its issue and not of its application. As to the second ground, they would admit that if the French patent had been granted to a stranger, it would have been part of the prior state of the art. Mr. Wetmore had sought to draw a distinction between the invoking of the prior French patent to negative the novelty of the patent in suit, and of invoking it as a part of the state of the art to limit the scope of the patent in suit, but he had ignored the distinction between invoking a prior foreign patent to the same inventor, and one granted to a stranger as a part of the state of the art, limiting a later American patent to the same inventor. He (Mr. Lowrey) believed that no precedent on that point had been established. His Honor must therefore determine whether the first half of section 4887 R. S. operated to protect an American patentee against having his prior foreign patent turned against him in court. Defendants had sought to treat the French patent as a part of the state of the art, by claiming that it was not like the patent in suit; then having on that ground obtained its admission into the state of the art, they had shifted their contention, and urged that it was substantially like the patent in suit. These clearly inconsistent positions could hardly be approved by the court. Complainants therefore contended that the platinum patent should be excluded from the state of the art while construing the patent on the carbon lamp. Now for the sake of the argument, he would assume the contrary, and regard the platinum patents as the nearest approach to the invention of the patent from the platinum side.

His Honor inquired whether there was any material difference in the description between the American and the French patent on the platinum lamp.

Mr. Wetmore said the French patent was a little fuller.

Mr. Lowrey remarked that the American platinum patent, being of later date, was by express decisions out of the state of the art.

His Honor observed that he had not supposed the American patent had any bearing on the state of the art, but had held different views as to the French patent.

Mr. Wetmore called his Honor's attention to a case in the Patent Office; the only one he had been able to find. In *Ex-parte Holt*, it had been distinctly held that when an application had been filed which would support a broad claim, and the applicant had made a narrow claim, he could not, unless he put in a saving clause, or else filed the application simultaneously with it, get a second patent for the broad claim.

General Duncan said that the relation between the two patents seemed to be very much like that found by the Supreme Court in *Hayden* vs. *Suffolk Company*, in which it had been held that the first patent was limited in view of the broad claim obtained in the second patent; a fact, as it seemed to him, of very great importance as bearing on the question of construction in the present case.

Mr. Lowrey, resuming his argument, said, *first*, the rule that it is not invention to substitute superior for inferior materials, in making one or more, or all of the parts of a thing, was a general rule, subject to certain exceptions which were as well established as the rule itself. The courts had applied that rule only in cases in which the adaptability of the substituted material had depended upon well-known characteristics and qualities. The exceptions had been so numerous that they have even led Justice Bradley to say that there was no rule of law, that the substitution of one material for another was not patentable. Mr. Lowrey then cited a number of cases in support of his contention that the substitution of carbon for platinum had involved a new mode of construction, and had developed new uses and properties in the lamps. He could see no escape from the conclusion that the substitution by Edison of carbon for the incandescent platinum material of the earlier patent, did abundantly constitute invention. To banish a substitution, at once so surprising and so successful, from the domain of invention, would be to go counter to all decisions ever rendered by the Supreme or Circuit courts on the subject, and counter to the whole purpose and spirit of the patent laws.

His Honor observed that it was, of course, well-known in the state of the art at the time, that carbon had these peculiar qualities of resistance and infusibility.

Mr. Lowrey replied that nevertheless it had not been known that it had the quality of resisting disintegration when properly protected, and that the proper protection had been discovered.

His Honor replied that the difficulty in these cases lay in the application of recognized and familiar principles of law to the peculiar facts of the case.

Mr. Lowrey, resuming, said that the invention resided in the combined use in the new carbon burner of the three facts in question; two of those facts had been known prior to Edison's day, as isolated facts, but the third one had been discovered by him. The patentability of the substitution of carbon for platinum did not reside alone in the newly-discovered fact, but in its combination, in the lamp, with the two known facts of the high specific resistance and of the infusibility of carbon. It had clearly required invention to correlate the two old facts and the one new one, and to utilize those facts in electric lighting by substituting carbon for platinum in an exhausted glass globe. He would close this part of the argument with Mr. Edison's own accurate and comprehensive statement of the whole matter:

> The discovery I made was, that a fine filament of carbon, under the conditions I had, did not disintegrate to any extent. That was the discovery as set forth in my patent; but the patent has also, in addition to discovery, some invention as well as discovery; in other words, it required invention to carry out the discovery which I made.

Mr. Edison might be ignorant of physical science but he was certainly a good lawyer, and could not have stated his case better.

His Honor remarked that Mr. Edison had compressed the whole argument in a very brief way.

In the "feeder" case—continued Mr. Lowrey—Sir William Thomson had been asked: "Suppose there had been a lamp at a certain time known to you, how would you have advised a person to place the conductors?" He said: "I cannot assume this knowledge without other knowledge that became public between 1878 and 1881. I cannot assume a reversal of the history of science; a displacement of the order of discovery, and the formation of ideas founded on discoveries in science;" and so he would have said that the discovery of the disintegration of carbon, under certain condilions, had been deferred by Providence until it could be made in its due order, as one of a succession of steps.

His Honor here remarked that he had not been impressed with the convicton that there was no invention in what Mr. Edison had done. The question was rather as to how much he had done, and what was the extent of his invention, for the purpose of determining what interpretation was to be put upon his patent.

Mr. Lowrey said he would speak next of the utility of the filament. He did not know whether he had sufficient time to fill the long-felt want of his brother Duncan; a definition of "filament" that would suit him. Justice Butt had not seemed to find much trouble; be had found the filment in the thing done, not so much referring to what had not been done. He had said a "thread" was a thread and a "rod" was a rod; and it had been found that rods and threads, under the engineer's calipers, had classified themselves into widely separated grades. The chasm which had been leaped under the impulse of Mr. Edison's discovery had been from 16 to 69; a leap from the shore of failure to to the shore of success.

Two controlling and essential conditions had been constantly insisted upon in the patent. It plainly taught that the greater the resistence and the less the radiating surface in any individual conductor, the better. Mr. Edison had brought over from his platinum experience, the notion of the difficulty of overcoming the fluctuation of the current by putting a great length of conductor into the lamp, and then masking it by coiling it away.

The first results of experience had taught him that that was not necessary, but not before he had given evidence of its influence, in giving color and form to his ideas, by making the drawing of the patent.

Gen. Duncan inquired whether Edison could have got that resistance by any process of carbonization known to the art at that time.

Mr. Lowrey replied that there was no reason to suppose that he could not have done so. Resuming, he said that his associate had reminded him that he had passed a point, to which he would for the moment return. He would cite several cases establishing the general rule that it was not invention to change the degree of a thing, or one feature of a thing, but those had all been changes of degree, having some utility for the particular purpose in view, but in each case it had been obvious before the change had been made, that the result desired could have been obtained by the change in degree. So far as Edison could be said to have merely reduced the cross-section and increased the length of such a carbon as that of King or Adams, he was yet far outside the rule, because those changes had operated cumulatively to enormously increase the resistance of the carbon, and had, moreover, resulted in a revolutionary change in the mode of operation, not only of the lamp, but of the entire system.

His Honor inquired whether there was proof in the record of any use of filaments made merely of the carbonized thread described in the patent.

Mr. Lowrey replied that none had been made except for purposes of experiment.

Mr. Curtis observed that Mr. Batchelor had said that he knew of no tar-putty lamps except some made for experiments in Paris.

Mr. Dyer pointed out that Professor Barker had said that one manufacturer used silk thread. He believed that it was admitted that the defendants had used silk thread.

Mr. Curtis said that the thread had been subjected to a peculiar process patented since.

His Honor remarked that he was anxious to know whether there was anything in the record showing the use of a filamentary thread made under any one of the modes described in the specification.

Mr. Lowrey replied that such had been made, but not for commerce.

Mr. Dyer said that it appeared that paper, a material referred to in the patent, had been used early by Mr. Edison. He called his Honor's attention to the fact that two of the defendant's lamps in evidence had carbons of paper.

Mr. Curtis added that the evidence also showed that the paper had been subjected to special mode of treatment—the Maxim hydrocarbon treatment—invented after the issue of this patent.

Mr. Lowrey in reply contended that this had been done, not to make a filament more a filament, but to protect the stability of the thing and produce uniformity of resistance. Both Dr. Morton and Mr. Shallenberger, had said that it was a misfortune that they had to do it. Mr. Lowrey said the complainants had used paper without treatment.

Gen. Duncan replied that the complainants had treated it electrically and had carbonized it on the pump. The patent had nothing to say about it, but as a matter of fact if they did not do it, they could not make the burner. Mr. Edison had said in his Canadian affidavit, that none of this material could be used without hydrocarbon treatment, except by processes which he himself knew, and could alone practice, but could not communicate to others, even to Batchelor, by any statement in words.

Mr. Lowrey remarked that the chief value of the Maxim treatment was to so far spoil the lamps that they might perhaps cease to be an infringement.

Resuming his argument, Mr. Lowrey said that the only essential thing was high resistance and small radiating surface. There was nothing essential about coiling; that was only a subterfuge to cheat nature out of some of the efforts she was making to keep the inventor back. The table of dimensions which had been put in showed that defendants' three lamps partook of the extreme characteristics of Edison's filamentary lamp, and not at all of the characteristics of the old lamps. While it was true that the knowledge of the particular laws of nature which had been utilized by Edison in making that change in the incandescent carbon, could be traced backward to times anterior to his work, it did not follow that in utilizing those laws by means of a compound change in degree of the prior incandescent carbons, he had exercised nothing beyond the expected skill of the electrical engineer; that skill had been expected a long time and had not arrived. Among the criteria which served to distinguish skilled electrical engineers who were *not* inventors, from those who *were* inventors, none was more striking than the fact, that merely skilled persons are invariably inclined to follow in the footsteps of their predecessors, while inventors are continually inclined to take new departures. If that criterion were applied to the case in hand, they would find that down to the latest date when anything had been published upon this subject, before the issue of the patent in suit and of the French platinum patent, the word of the most advanced who were not inside of Mr. Edison's laboratory had been: "Get your resistance down." Edison had changed both those degrees so radically as to increase the resistance of his carbon twenty-fold or more. A change of degree so extensive as this had been foreseen by Edison to involve radical and extensive changes in the mode of operation of the lamp, and in the words of Lord Justice Lindsley, "to turn failure into success." Such revolutionary plans were neither found nor executed by mere electrical engineers.

It might be said with truth, that defendants' methods of analysis and comparison of what Edison had produced with the laws of nature before known, if they had been applied to the Bell telephone or to the Morse telegraph, would have abundantly negatived the presence of invention in either of those marvelous contrivances.

His Honor here took occasion to observe that he had not been much troubled about the question of invention; his trouble had been to find out whether the invention had been patented.

Mr. Wetmore had contended—continued Mr. Lowrey—that the first claim of the patent was so limited in several of its features by the descriptive part of the specification, as to enable the defendant to escape the charge of infringement. The most noticeable of these features was the spiral form of the carbon. The complainants had contended that a carbon filament, having substantially such a resistance, and such a radiating surface, as that described in the patent, was substantially like it, whether it were coiled or otherwise arranged. In support of this legal position Mr. Lowrey read extracts from the decision of the Supreme Court in *Winans* vs. *Denmead* and in *Lake Shore R. R.* vs. *Car Brake Shoe Co.* In the present case the third claim expressly called for the coiled carbon. If the first claim were to be so construed by implication, then it must be identical with the third; a highly improbable conclusion.

Mr. Wetmore's contention that the method of cementing the filament to the leading-wires must be imported into the first claim by the words "secured to metallic wires as set forth" appeared to him to be unreasonable, because the claim undoubtedly covered a manufactured article and not a process of making such articles. There was no statement nor implication in the patent that the filaments could not be joined to the wires in any other way. The remaining limitation which Mr. Wetmore sought to import into the first claim made it call for a filament of carbon of high *specific* resistance, but even this could not enable the defendants to avert infringement, for all their lamps contained such filaments, in the only sense in which the quality of high specific resistance could be ascribed to the filament of the first claim. There was a bold and limitless audacity in counsel, in alleging that they had not got carbon of high specific resistance, because they had taken a carbon made by complainant's plan, and spoiled it by reducing it, although its resistance was still enough to give them a profit derived by the form they had learned from complainants. Mr. Wetmore had sought to limit the second claim by attaching four limitations to its first element, the carbon filament; namely, spiral form; high total resistance; high specific resistance, and the particular method of attachment described. The spirality of the carbon was a matter of form and not of substance, and therefore could not be imported into the second claim by implication any more than into the first claim. A carbon filament, moreover, was not necessarily definable in terms of total resistance. It might have a low total resistance and still be a filament within the definition of the English Courts, provided its resistance was high in proportion to its radiating surface.

A great deal had been said about 100 ohms, as if a lamp could never be made without a resistance of 100 ohms; the lamps were various, according to candle-power. If the carbon was cut short they got a less total resistance, and a less candle-power, but out of the same filament, acting by the same law. How absurd to suppose that Mr. Edison intended to disappoint and oblige these infringers, by never supplying to the public lamps with less than 100 ohms resistance! But even were the limitation of high total resitance implied in the second claim, none of defendants lamps were less than 40 ohms, and hence they could not thereby escape from the claim, for that was a high resistance relatively to 4 ohms. It was high, in the sense that it enabled users of the lamps to operate them on the plan contemplated by the patent, whereas the older low resistance carbons could not have been operated upon that plan. It was illogical to assert that a statement that a particular object came within a particular category, excluded other objects from that category, differing from it only in degree, and that to an immaterial extent, in respect of the purpose and mode of operation of the thing under discussion. Mr. Lowrey said, following the decision in *Tilghman* vs. *Proctor*, in the Supreme Court, that the defendants had not averted infringement by giving to their filament a resistance as low as 40 ohms, because that the patent was satisfied with "great resistance" as compared with the resistance of one to four ohms of the prior art. Mr. Lowrey contended further that the carbon filament of the second claim was not necessarily definable in terms of specific, any more than of total, resistance; but even if that limitation were attached by implication to the first element of the second claim, none of defendants' lamps would fall outside of that claim, for their specific resistance was not low enough to prevent their offering a great resistance in proportion to their radiating surface. Mr. Wetmore's contention that the particular method of uniting the filament to the wires must be implied in the second claim, is even more unreasonable than that it must be attached to the filament of the first claim. Whatever method of union was sufficient to enable the current to pass, satisfied the conditions of the second claim, and it would be extremely unreasonable to confine it to the particular union described. Thus it plainly appeared that even if there were any ground for importing those limitations into either of the claims, they were nevertheless abundantly broad to cover all the lamps of the defendant.

In the case at bar—continued Mr. Lowrey—the question of infringement to be decided was whether Mr. Edison should hold or should lose the fruits of his genius or his labors; or whether he should hold his due portion of the fruits of that genius and labor in the field of electric lighting. It was impossible that he should hold all those fruits, because they were so extensive and so splendid that the whole civilized world was participating, and would always participate, therein.

The final defense to which it yet remained to reply was the defendant's contention that the patent was void because the description was not in such full, clear and exact terms as to enable any person skilled in the art to make and use the carbon lamps of the patent.

This was a question of evidence, and not of construction. It could only be supported by evidence of persons skilled in the art to which the invention pertained, therefore he would merely call the attention of his Honor to the portions of complainants record wherein such evidence as the defendants had taken to support that defense had been totally swept away.

In conclusion, Mr. Lowrey said that his brother Wetmore had eloquently appealed to his Honor not to punish the twenty millions of capital which had been invested in this business. He would not reply to any such argument, but should ask his Honor to consider those greater millions that had been invested in this business, subject to all the effects of these piracies, and which were being used in the prosecution of an honorable and legitimate industry. Mr. Edison had said that he makes his calculations intuitively; he sees the inner motions and processes of nature. Those men who had money to invest had a like genius for their occupation; they saw intuitively how much it was worth while to risk in an unlawful course for a great profit. They knew what they were about and they took their chances; they did not require in that respect, the protection of any court.

Ever since he had come into the case, concluded Mr. Lowrey, he had been under the influence of a deep sentiment. The day that Benjamin F. Thurston had died, he had been in this city to confer with the counsel in this case in respect to the very duty which he (Mr. Lowrey), had now performed. When that heavy task had fallen from Mr. Thurston's relaxing hands and had been confided to his own feebler strength, it had seemed to him that looking his Honor in the face, who had been the friend of both, and the friend of their associates and adversaries, that he could never speak in his place with the idea that he had been deservedly chosen for any such function. Personal pride had seemed to forbid it; but it also seemed that he must put his name—by this reference, since it was not otherwise there—into this great record of the case which he had really loved, and which he had perfectly trusted and believed in. On that day, as Emerson had said: "Envious death robbed us all, to aggrandize one funeral." He had undertaken to perform that duty as well as he could, and he had done his best.

ANOTHER SILVER MEDAL FOR THE CLARK ELECTRIC COMPANY.

At the fourth annual exhibition of the Amateur Photographers Society of New York, held in May, 1891, the Clark Electric Company was awarded a silver medal of excellence for their arc lamp for electric optical lantern apparatus. This is the first and highest medal ever issued by the society for electric light for optical purposes in photography.

This opens up another channel of usefulness for the Clark apparatus.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JULY 7, 1891

Alarms and Signals :—

Annunciator, M. Garl, 455,316. Filed Sept. 26, 1890.
A needle annunciator.

Electrical Watchman's Clock, H. S. Park, 455,352. Filed July 1, 1890.

Watchman's Time-Detector, A. Newman, 455,410. Filed Mar. 11, 1890.

Watchman's Time-Recorder, J. A. Lannert, 455,440. Filed Jan. 5, 1891.

Grave Annunciator, W. H. White, 455,446. Filed May 22, 1890.
For the relief of persons buried alive.

Clocks :—

Self-Winding Electric Clock, F. L. Gregory, 455,532. Filed Apr. 2, 1891.
Electro-magnetic device for winding a weight-actuated clock.

Distribution :—

Transmission of Alternating Currents of Different Phase, M. Von Dolivo-Dobrowolsky, 455,683. Filed Mar. 28, 1891.
Claim 1 follows:
The combination of a dynamo-electric machine having a plurality of coils or sets of coils in which independent alternating currents of relatively differing phases are induced, a transformer provided with as many primary coils as there are induction-coils or sets of coils in the dynamo, and with a smaller number of secondary coils, separate connections between the induction-coils of the dynamo and the primary transformer-coils, and mains connected to the secondary coils of the transformer.

Dynamos and Motors :—

Friction-Gearing for Dynamos, F. L. McGahan, 455,488. Filed Dec. 26, 1890.

Multipolar Dynamo, A. L. Riker, 455,517. Filed Feb. 7, 1891.
Relates to the construction of field-magnets which are laminated.

Carbon Brush and Holder Therefor, A. L. Riker, 455,518. Filed Mar. 25, 1891.
Holds the carbon brushes against the commutator with yielding pressure.

Pulsating-Current Reciprocating Electric-Engine System, C. J. VanDepoele, 455,520, Filed Mar. 23, 1889.
Relates to improvements upon the inventions patented Apr. 2, 1889, No. 400,809, and April 9, No. 401,231.

Electric Motor, L. G. Goode, 455,711. Filed Aug. 22, 1890.
Relates particularly to a reciprocating motor.

Electric Motor or Generator, W. F. Brown, 455,726. Filed Aug. 21, 1890.
Has two armatures upon a common shaft, an intermediate cummutator upon the shaft, the several windings of the two armatures being connected respectively to the opposite ends of the commutator segments.

Galvanic and Thermo-Electric Batteries :—

Galvanic Battery, H. C. Sample, 455,693. Filed Dec. 2, 1889.
Especially designed for small batteries of the portable kind. By a tilting motion of the battery cell the electrodes are immersed in the fluid or withdrawn.

Lamps and Appurtenances :—

Combined Fuse-Block and Incandescent Lamp, H. E. Swift, 455,366. Filed Sept. 29, 1890.

Lamp Socket and Switch and Circuit Closer Therefor, H. P. Ball, 455,55 Filed Dec. 16, 1890.

Electric Arc Lamp, J. W. T. Olan, 445,576. Filed Jan. 12, 1891.
Relates to the class of arc lamps in which the arc is operated in a vacuum or in a chamber containing a rarefied inert gas.

Measurement :—

Electric Meter, J. J. Wood, 455,524. Filed Oct. 30, 1890.
Claim 1 follows:
The combination, with an electric meter as a means for correcting the registry thereof, of a shunt around the meter and automatic means in the nature of a rheostat controlled by the current being measured for diverting through said shunt varying proportions of current from time to time as the total current varies, such rheostat being so proportioned that the current so diverted shall be graduated for each quantum of current proportionally to the normal overregistry for such quantum, whereby the registry is reduced to direct ratio to the current.

Electric Meter, J. W. T. Olan, 455,575. Filed Dec. 29, 1890.
Employs, as a measure of current, a rotator propelled by gas produced by decomposition of an electrolyte.

Medical and Surgical :—

Electric Belt, C. A. Bogardus, 455,680. Filed Feb. 24, 1891.

Metal Working.

Method of Electric Welding, E. Thomson, 455,420. Filed Feb. 19, 1891.
Employs a local cooling effect to the work in the heating portion of the circuit near the points of application of the contacts and between them and the welding points.

Securing Metal Bands on Wooden or other Articles, E. Thomson, 455,421. Filed Feb. 24, 1891.
Welds the bands, by electricity or otherwise, after they are placed in position.

Miscellaneous :—

Electrical Walking Toy, J. B. Kibler, 455,545. Filed Mar. 17, 1891.

Apparatus for the Defecation of Saccharine Juices by Electricity in the Manufacture of Sugar, E. Maigrot & J. Sabates, 455,631. Filed Apr. 15, 1889.

Switch-Board for Electric-Fence Stations, D. H. Wilson, 455,696. Filed Aug. 25, 1890.
For use in connection with wire fences in which an electric current is employed for the detention of fugacious cattle.

Railways and Appliances :—

Electric Locomotive, N. C. Bassett, 455,298. Filed Oct. 30, 1890.
Relates particularly to the class of motor cars designed to draw passenger cars. Motor is mounted directly upon the truck axles with its weights supported upon springs; variable friction gearing is provided for varying the speed of the locomotive.

Trolley-Pole Stand, J. R. Griffiths, 455,322. Filed Jan. 20, 1891.
Permits a sweep of the trolley pole to a horizontal, front or rear, and a sufficient side movement.

Conductor for Electric Railways, W. H. Knight, 455,339. Filed May, 11, 1885.
Employs a slotted conduit flush with the street and having its inner surface adapted to shed water away from the slot; the conductors have a bare contact surface parallel with the slot.

Electric Railway, W. H. Knight, 455,340. Filed May 11, 1885.
Relates to a conduit system; provides, through a swiveling connection, for the free lateral movement of the contact device, so that it may accommodate itself to irregularities in its path.

Electric Railway, W. H. Knight, 455,341. Filed Apr. 29, 1887.
Supports the conductors as far as possible above the bottom of the conduit.

Electric Railway, W. H. Knight, 455,342. Filed Oct. 16, 1888.
Provides a transverse movement of the plow or contact device, in a conduit system, whereby it may pass entirely across from one side of the car to the other.

Electric Railway Plow, W. H. Knight, 455,343. Filed Mar. 5, 1889.
Relates to the method of supporting the contact device.

Conduit for Electric Railways, W. Bradley, 455,447. Filed Nov. 24, 1890.
A construction adapted to prevent the entrance of water or dirt.

Electric Railway, E. W. Rice, Jr., 455,454. Filed Mar. 30, 1891.
Employs two or more supply conductors along a road each carrying a different voltage, and devices by which the circuit of the motor may be completed through either of the different supply conductors.

Train-Signaling Apparatus, L. F. Jordan, 455,510. Filed Nov. 16, 1889.
For establishing communication between the engineer and the conductor.

Electric-Motor Car-Truck, J. F. Seiberling, 455,581. Filed Mar. 9, 1891,
A method of sidgle reduction gear.

Power-Gearing for Vehicles, E. A Sperry, Reissue 11,177. Filed May 18, 1891.
Original No. 434,098, Aug. 12, 1890.

Telegraphs :—

Telegraph Key, R. W. Green, 455,320. Filed Feb. 10. 1890.
A self-closing key.

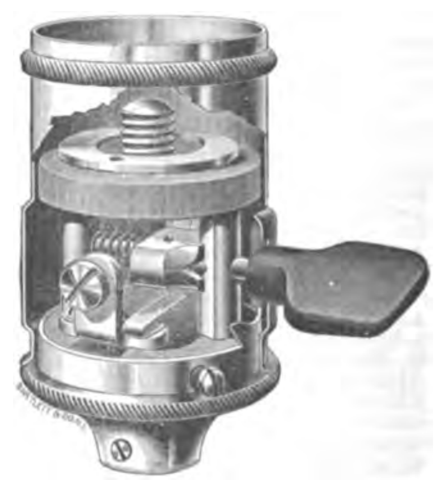
Quadruplex Telegraphy, C. D. Haskins, 455,398. Filed Nov. 19, 1887.
Relates to means for avoiding false signals upon the neutral relay by reversals of current.

Telephones and Apparatus :—

Support for Telephones, W. J. Myers, 455,722. Filed Jnne 3, 1890.

UNION ELECTRIC MFG. CO'S. NEW SOCKET AND ROSETTE.

The Union Electric Manufacturing Company, of Bridgeport, Conn., have recently brought out a new and improved socket, which is meeting with general approval, on account of its



A New Socket.

mechanical and electrical excellence. Our illustration shows the general design so well that description is unnecessary. There are very few parts to it, the chief novelty being in the method of holding the key in position by peculiarly shaped projections on the key, pressed up against one of the frame posts by a spring. In the most recent form the contact ring on the top is done away with and two screws are substituted, one going into each of the frame posts. The whole socket can then be easily taken apart for repairs when necessary.

A new rosette which the same company is manufacturing is having a large sale. The silk cord is fastened into the lower half in the usual manner, and the projecting lugs are inserted under the small brass pieces in the base, and fastened by screws, forming an excellent contact.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

An advertiser is always the first to get out of a trade calm, because his sails are set ready for the favoring breeze.—Confucius.

THE ELECTRIC GAS-LIGHTING CO.'S IMPROVED PENDANT BURNER.

WE illustrate in the two accompanying engravings a new pendant electric gas-lighting burner, which possesses a nnmber of improvements over any other form. It has been called the double contact and pass-by ratchet burner. Fig. 1 shows the burner

FIGS. 1 AND 2.

ready for lighting, which is done in the ordinary way, but with this advantage, that the lower end of the German-silver electrode comes in contact with a little projection on the disc, which makes a positive connection to the ground, and thereby prevents all possible trouble with an imperfect ground caused by an accumulation of grease on the gas-cock. This projection also serves to prevent the German-silver electrode from passing through the flame on the back stroke, as shown in Fig. 2, so that there is no danger of the electrode being held in the flame either purposely or accidentally, whereby it would lose its temper and conductivity. The burner is manufactured exclusively by the Electric Gas-Lighting Company, of Boston.

BERLIN IRON BRIDGE CO.

The new works of The Berlin Iron Bridge Company, of East Berlin, Conn., are now completed; the company have all the machinery placed and are now running full time, employing in all departments 400 men. The building is made entirely of iron, no woodwork being used about the construction except for the window sashes. The roof trusses are all provided with trolley cars with which to move material back and forth about the building, and three lines of narrow-gauge tracks extend the entire length of the building—these three tracks being connected at each end of the building by a transfer table. There is a skylight on each side of the roof, extending the whole length of the building, and for a distance of ten feet down from the eaves of the building on all sides it is made entirely of glass, so that the interior of the building is thoroughly lighted. The company have purchased a large amount of new machinery, and are now prepared to furnish all kinds of structural ironwork, including iron buildings and iron roofs for electric plants, on very short notice. Their large experience in this class of work and their improved facilities insure first-class work at a reasonable price.

MR. LEE L. MURRAY, of Melbourne, Australia, has been in Boston for a few days looking up electrical devices for adoption in Australian cities. Mr. Murray is particularly anxious to find a good alternating motor and arc lamp, as most of the lighting in that country is done on alternating circuits.

ALUMINIUM CARBON CO.

The above company, a recent comer in the field of arc-light carbon production, is attracting considerable attention, not only by its new departure, but by the excellence of its manufactures. It has established itself with headquarters at Room 69, Coal and Iron Exchange, Buffalo, N. Y., and carries on its factory at Lancaster, N. Y. The company has as its officers Andrew Cant, president; R. J. Getz, vice-president; Fred V. Doty, secretary and treasurer; and W. H. Boulton, as superintendent. The list is such we think as to inspire no little confidence among "old time" central station men, who know what good carbons are and who have been the makers of them. Mr. Doty, it may be added, is also the general manager. The company write us: "We are now producing a superior line of carbons to those now on the market, and can safely guarantee that they will burn 25 per cent. longer than any carbon now on the market, and also will produce a perfectly white and steady light." Evidently, a company that has this faith in its product means business and will get no small share of trade.

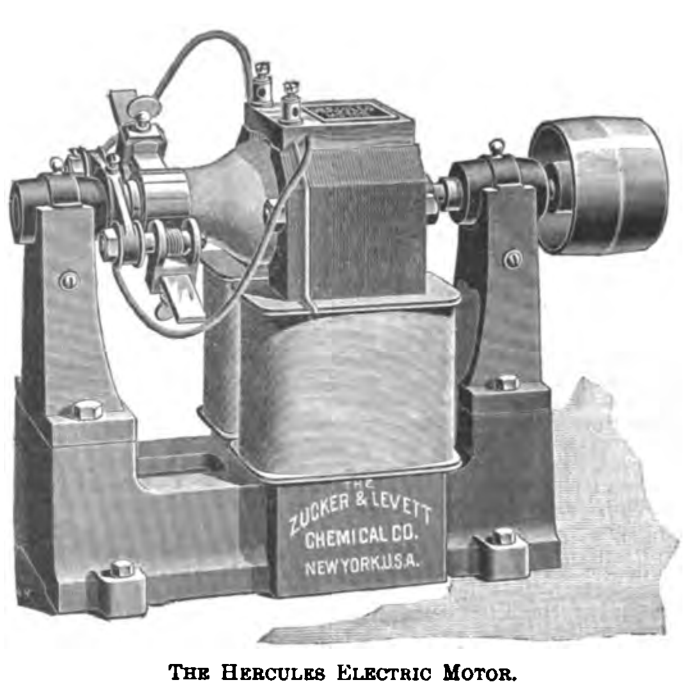
THE HERCULES ELECTRIC MOTORS AND DYNAMOS.

THE accompanying cut illustrates a new motor just brought out by the Zucker & Levett Chemical Co., of this city. The motor is of the inverted horseshoe type, in which the whole of the magnetic circuit is stamped out of one sheet of best Swedish iron, the sheets being bolted together to form the magnet frame.

The plates are thoroughly insulated to prevent the generation of Foucault currents and consequent heating. The field coils are separately wound on brass spools, and the distance between the magnet cores is slightly larger than twice the depth of one coil, thus allowing the same to be slipped over the core.

The plates of the armature, which is of the modified Siemens type, have teeth forming longitudinal channels on its periphery, in which the coils are wound. These teeth, besides reducing the magnetic resistance to a minimum, entirely prévent the coils from shifting and consequent burning out of the armature, due to short-circuiting. The magnet frame is bolted to an iron base, having iron standards and self-coiling bearings even in the smallest size of machines. By this method of construction a highly efficient and simple form of motor is obtained.

There is no sparking if the commntator and brushes are kept in fair condition, the magnetism of the field greatly overpowering that of the armature even when the machine is working at full load. The automatic motors are usually plain shunt wound with an armature of extremely low resistance. The fan motors are plain series wound and run a six-blade 12-inch propeller fan at 1,600 revolutions per minute, taking one ampere at 120 volts.

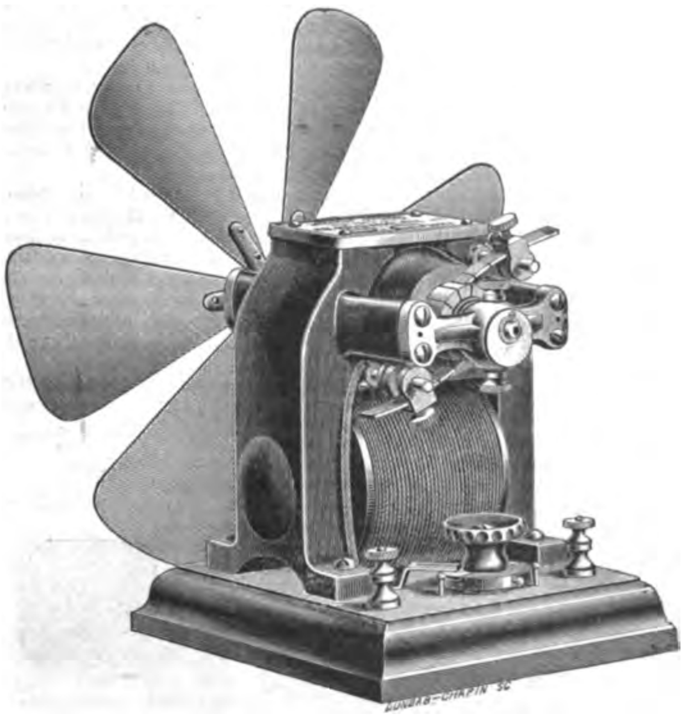


THE HERCULES ELECTRIC MOTOR.

The mechanical details of these machines have been very carefully worked out and all parts are adjustable. Quite a number of the Hercules fan outfits are in daily use and are giving general satisfaction. These machines will be manufactured in all sizes from one-eighth horse-power up, for both light and power.

THE HOLTZER-CABOT "BONNIE BREEZE" FAN MOTOR.

THE Holtzer-Cabot Electric Co of Boston, Mass., well-known manufacturers of standard electric bells, annunciators and general electric supplies, have recently added to their already extensive works a department for the manufacture of electric fan motors. We illustrate the Holtzer-Cabot ⅛ h. p. motor with fan on this page. The machine shown in the cut has a Norway iron field core with malleable cast pole pieces, a drum armature with a very substantial commutator (nothing but mica insulation being used). It has self-oiling bearings, with phosphor bronze journals and in mechanical detail is claimed to be more nearly perfect than anything heretofore attempted in the small motor line. It has been found, it is said, to require no more current to drive a 12 inch fan at its slow speed than was found necessary to drive the ⅙ h. p. motor of another make when running free, so perfectly lubricated were its journals and so well balanced magnetically its armature. It is provided with a switch giving three changes of speed to the fan and is wound for circuits of any potential. It is heavily japanned and furnished plain or nickel-plated. The drum type armature was selected as being the most durable and efficient, it having been decided to sacrifice on account of cost no feature which rendered it possible to obtain greater durability or higher efficiency in the motor.



THE "BONNIE BREEZE" FAN MOTOR.

The company does not believe that the demand of the present day is for a fan motor whose special merit is that it can be easily repaired, but rather that the demand is for one that does not get out of repair, and they have here made one which they are ready to guarantee to be permanently serviceable. Especial attention, however, has been given to making the machine interchangeable in every part, which is true of all apparatus manufactured by this company, so well known for the high and "standard" quality of its work.

We are informed that the Holtzer-Cabot Electric Co. have secured the services of Mr. E. S. Pillsbury in this department of their works. Mr. Pillsbury has had an extended experience in the line of small electric motor manufacturing, having had employment with both the pioneer manufacturers of fan motors, viz., the "C. & C." Motor Co. and the Crocker-Wheeler Motor Co.

ELECTRICAL FIBRE CARBON CO.

A few weeks ago we made reference to the formation of this company. It has now fitted up a very fine factory at 1234 to 1236 Michigan avenue, Detroit, Mich., and is pushing the manufacture of its new carbon battery and other specialties produced by its new processes for the treatment of raw carbon. The company is in excellent hands, John R. Markel being president, John H. Davis, vice-president, and Eugene Klein, secretary and treasurer, the last named being also an expert chemist. Mr. Markel is an old electric light representative, while Mr. Davis is a pioneer in the carbon industry.

CENTRAL ELECTRIC CO.

The Central Electric Company have recently taken some very large orders for electroliers and other electric light fixtures for several public buildings in the Northwest. They report a large trade in these articles and that the demand is for better goods than have heretofore been supplied.

At a recent life test of 100 Packard lamps by a superintendent who is generally considered extremely finical on the question of lamp efficiency, the average life was found to be 2,118 hours. The Central Electric Company are handling these lamps in the West and report that their sales are constantly increasing. The capacity of the factory is now being doubled to meet this new demand

The Central Electric Company are showing samples of a new porcelain insulator, which they will place upon the market within a few days.

THE WIGHTMAN ELECTRIC MANUFACTURING COMPANY.

A number of the railway motors of the Wightman Company, a description of which appears in another column, are already running very successfully in Auburn, N. Y., and in Scranton and Easton, Pa., and large orders from these and other places necessitate the running of the factory night and day. The great increase of business has compelled the company to erect new buildings, which will soon be completed. The following letter indicates the reception with which these motors are meeting at the hands of railway men:

AUBURN, N. Y., June 29, 1891.

The Wightman Electric Manufacturing Co.,
Scranton, Pa.

Gentlemen:—We ran your car yesterday with heavy loads and are more than pleased with it. It is very fast and makes no noise whatever, and seems about as near perfection as anything can be.

Very truly yours,
AUBURN CITY RAILWAY CO.
(Signed) G. W. WELLS, Superintendent.

The work of this company is characterized throughout by simplicity and durability, and it is rapidly gaining a reputation for the superior quality of its products.

WANT THEIR OWN NEW COMPANY.

During the convention of the Order of Railway Telegraphers in St. Louis the newspapers were allowed to have only so much of the proceedings as the Press Committee thought should be printed. Since the adjournment it has been learned that one of the most important subjects considered was the formation of a new telegraph company, to be owned and controlled by operators. This matter was discussed, and is said to have been put in a fair way for final accomplishment. The new company is to capitalize at $2,000,000 and be organized, officered, and manned by men of known standing and ability in the telegraphic profession. The money required will be forthcoming, judging from the declaration of certain supporters of the scheme, who say that the order had the cash and time to devote to it.

MESSRS. DUBOIS & DUBOIS, of Washington, D. C., have secured the *Journal of Useful Inventions* and have merged all its rights, title and interest with the *Inventive Age*, which, it may be expected, will be more helpful and instructive than ever.

OKONITE ON SHIPBOARD.—The White Star Line steamer "Teutonic," which sailed recently for Europe, carried among its passengers Captain Willard L. Candee, of the International Okonite Co., Limited, New York.

NEW YORK NOTES.

MR. W. R. MASON, the general manager of the Electric Merchandise Co., Chicago, favored us with a call a few days since. He reports a most encouraging outlook for the live company which he represents, several large contracts having been taken during the last few weeks. The Merchandise Co., as selling agent for the Burton Electric Heater, of which company Mr. Mason is president, has been doing good work in calling attention to the merits of that device, and the visit of Mr. Mason to New York was by appointment with some of the leading officers of one of the largest steam roads, whose management have decided to heat some of the special first-class trains by the Burton Electric Heater. After consultation with Mr. S. Dana Greene, who is consulting electrician of the company, with reference to the best plan of equipping the cars, arrangements were made and the patrons of at least one road will ride next winter in safety, having no fear of either being roasted or scalded in case of an accident.

MR. W. F. D. CRANE, of the Engineering Equipment Co., reports considerable demand for the Kellogg pole, which his enterprising company is energetically pushing into the electric railway field. Mr. Crane has just returned from a trip which carried him as far as Chicago, and he says that advertising undoubtedly pays. As he expresses it, "Our pole 'ads.' tell so much that some people seemed to know as much, if not more, about its good and bad points and desirable features than I did. Its characteristics had evidently appealed to them, and they recognized a good thing when they saw it." The company has also done good business with the Boston trolley, line materials, Habirshaw wire and other specialties for which they are agents, several nice orders having been received lately.

MR. CHARLES A. SCHIEREN has left on the steamer "Fürst Bismarck" on a short trip to Europe. The principal reason for his going is to visit the International Electrical Exposition at Frankfort, where he will inspect the various devices for transmitting power by belting exhibited there. From a letter obtained lately we learn that the "American" leather link belt, exhibited by the American Leather Link Belt Co., attracts universal attention, and is so much superior to all European link belts exhibited, that the other exhibitors have actually withdrawn all link belts from the exposition.

SCHIEREN BELTS.—Orders for their perforated electric belting have been secured by Chas. A. Schieren & Co., Ferry street, this city, from the Columbus Consolidated Street Railway Co., Columbus, O., which takes six 18¼-inch double belts. They have also furnished the belting for the Worcester, Leicester and Spencer, Mass., Street Railway Co., namely, one 40-inch and five 12-inch belts. They report quite a fair demand for the perforated belt for street railway purposes.

E. G. BERNARD & CO., Hall Building, Troy, have recently installed a neat isolated plant in the country residence of Mrs. W. H. Hart, at Fernwood. A United States dynamo is driven by a Case engine, and is supplemented by a set of 30 cells from the Electrical Accumulator Co. The plant is in the care of Mrs. Hart's gardener, and runs 76 lamps, all told. Dynamo and engine are connected by the Evans friction cone system.

MR. J. W. PACKARD, general manager of the New York & Ohio Company, of Warren, Ohio, paid us a visit this week and reports business very good indeed. He had just received a telegraphic notice of an order from St. Louis for 4,000 Packard lamps, 2,000 52-volt lamps and 2,000 104-volt lamps, making 4,000 in all. Mr. Packard came to New York with a view of attending the meeting of the Lamp Manufacturers' Association.

NEW ENGLAND TRADE NOTES.

THE JEWELL BELTING COMPANY, of Hartford, don't appear to feel the general dullness of trade, but, on the contrary, Mr. Newton reports that they have never had so many orders, especially from electric light plants. That the Jewell belt is meeting with hearty approval is abundantly proven by the amount of new business that they get, and by the warm letters of appreciation which they daily receive from their customers. Among their most recent sales are the following: Cedar Rapids Electric Street Railway Company, Cedar Rapids, Iowa, complete equipment; Springfield Electric Light Company, Springfield, Vt., complete equipment; Omaha Electric Street Railway Company, Omaha, Neb., complete equipment, embracing one 48-inch double belt; Jamestown Electric Light Company and Jamestown Street Railway Company, Jamestown, N. Y., complete equipment; Amsterdam and Rockton Street Railway Company, Amsterdam, N. Y., complete equipment; Wautaûga Lighting and Power Company, Johnstown City, Tenn., two 39-inch double belts.

THE EDISON ELECTRIC ILLUMINATING COMPANY, of Boston, have purchased a large lot of land on Atlantic avenue, for the purpose of building a large central station, where they can use compound condensing engines. No settled plans have yet been adopted, as they will not commence building for some time, owing to present leases. Should they commence building soon, however, it is probable that the vertical compound engines and generator combined, manufactured by the Edison General Electric Company, and recently described in THE ELECTRICAL ENGINEER, would be adopted.

MR. F. E. PETTINGELL, of the Pettingell-Andrews Company, has at last got sufficiently recruited to be able to attend to business once more, and his numerous friends are all glad to see him back in his usual place. Mr. Pettingell has had quite a serious sickness since his return from Europe, and has not been able to attend to business for over a month.

THE PETTINGELL-ANDREWS COMPANY, of Boston, have added a new department to their already existing large business, namely, that of bells, batteries, push-buttons, switches, office and annunciator wire, &c., and will carry a complete line of these light goods, in addition to their large stock of the heavier supplies for electric light and railway purposes.

THE REDDING ELECTRIC COMPANY, of Boston, have taken the selling agency for the Hyer-Sheehan electric motor, described in the last number of THE ELECTRICAL ENGINEER. They have also in view the agency of the Columbia incandescent lamp, and are making arrangements for the agency of a first-class wire. With these the Redding company will be well equipped to do a general electrical supply business, and will be pleased to furnish prices to all enquirers on any line of electric specialty. The sale of the Star Electrix goods still keeps brisk.

THE RUSSELL ARC LAMP continues to attract many new customers, and the Russell Electric Company have all they can do to fill their orders. The "Baby" lamp is anxiously awaited, as they have numerous orders for it, but have been delayed somewhat in the machinery for making them. When the machinery is ready, a large business is expected, and the "Baby" lamp will have the same excellent workmanship as the larger lamp, and all the parts will be interchangeable.

MR. O. K. STUART, a gentleman well known in electrical circles, has now got thoroughly settled down as treasurer of the Germania Electric Company, of Boston, and reports his company as making active preparations for fall trade. The Germania company are at work on a number of new devices, which when perfected will prove valuable accessories to their present large business. Mr. Peter Claus, of New York, has taken the agency for New York City and State.

THE NEW HAVEN INSULATED WIRE COMPANY, of New Haven, Conn., the manufacturers of the well-known Helmet brand of insulated wires, recently sold by the Empire City Electric Company, of New York, will continue to manufacture their goods, as there is a large demand for them, and will hereafter supply dealers and central stations direct. Messrs. Hague and Bean will continue in the management.

M. J. FRANCISCO & SON and the Rutland, Vt., Electric Light Co. have opened large new offices in Rutland, taking the entire first floor and basement of the *Herald* building in that city. The fittings and appointments are most luxurious and handsome, and electric lights, electric motors, &c., add to the general comfort The opening was made the occasion of a reception recently.

PHILADELPHIA NOTES.

MR. B. FRANK JOHNSON, the general agent of the Interior Conduit & Insulation Company, has received a letter from Gov. Gorham, secy. of the old Point Comfort Hotel Company, in which he states that they have found no necessity for inspection of their new building in which an entire conduit installation was recently made; that their insurance agent has placed over $150,000, covering owner's as well as builder's risk, and has required nothing of them, the directors. The contract for the new Betz office building, on South Penn Square, has been awarded to Allen B. Rorke, builder, of this city, and work of tearing down the old church and erecting the new building will be begun at once. The contract for the electric work has not yet been awarded, but the system of the Interior Conduit & Insulation Company has been called for in its entirety for the lighting of the building.

MR. CHARLES H. FISHER, agent for Chas. A. Schieren & Co., reports business as excellent. He has recently received orders from the following companies for their famous perforated belting: Home Electric Light and Power Co., Tyrone, Pa.; Jenkinton, Pa., Electric Light and Power Co.; Shamokin, Pa., Electric Railway Co.; Merchants' Electric Light Co., of this city, and the Edison Electric Illuminating Co., of both Bellefonte and Lebanon, Pa.

THE STAR ELECTRIX CO. are about to move their office and factory from Wallace street to the large Warner Building, 641 Broad street, where they will occupy several floors, and with the addition of more machinery they will double their present capacity for turning out the specialties so favorably known to the trade.

MESSRS. WALKER & KEPLER are busily at work on the jewelry store of J. E. Caldwell & Co., of this city, which when finished will doubtless be the handsomest lighted store room in the country. The Interior Conduit Company's tubing will be used throughout the building.

THE EUREKA TEMPERED COPPER CO., of North East, Pa., has kept its factory running on full time, notwithstanding the general dullness in business circles, and has orders on the books for an output of at least sixty days.

MR. G. A. WILBUR, the Philadelphia agent for the Fort Wayne Electric Co., has sold a Wood 60-arc light dynamo to the Southern Electric Light and Power Co., of this city.

MR. W. C. WRIGHT, of Wright & Starr, has just been granted a patent on a fluid clutch which can readily be adapted as a hydraulic motor or a fire pump.

Mr. Wright has had an application pending for over two years for a conduit system for electric railways which has just been granted.

MR. CHARLES P. PEROT has been elected a director of the Equitable Electrical Construction Co., of this city.

MR. S. ASHTON HAND, first vice-president of the Equitable Electrical Construction Co., is spending the summer at the Bellevue Hotel, Wayne, Pa.

MR. NORMAN MARSHALL, secretary of the Star Electrix Co., sailed for Europe last week on a short business trip.

MR. G. A. WILBUR, agent for the Fort Wayne Electric Co., has contracted to furnish the Franklin Electric Light Co. with a 1,000-light Slattery alternating dynamo with full station equipment. He has also installed two 40-light Wood arc dynamos and 75 2,000 c. p. lamps for Geo. Kelly & Co., 810 Market street.

WASHINGTON NOTES.

THE "GLEN ECHO" ELECTRIC RAILROAD has been started with current from the power-house of the Georgetown & Tennallytown R. R., their own station not yet being finished. Large crowds go out daily to enjoy the "feast of reason and flow of soul" set out at our own "Chautauqua." By-the-by a series of lectures on electricity is to be delivered during the summer at this resort. The road makes the grounds so easy of access that there should be no lack of interest.

J. W. BURKET & Co. are wiring the new addition to the U. S. Treasury Dept. The addition will be occupied by the draughtsmen of the Supervising Archtects' office and over each desk will be a 50 c. p. lamp with a McCreary ground-glass reflector. The building is ventilated by means of two C. & C. combination exhaust fans, andmotors furnished by the Washington Construction Company.

THE CHESAPEAKE & POTOMAC TELEPHONE CO. have recently executed a large mortgage on their property to obtain money for their extensive underground work. As an officer of the company expressed it: "They are providing for the 20th century in more ways than one."

THE U. S. ELECTRIC LIGHTING CO. have broken ground for a new building on the lot adjoining the present station. It is purposed to erect a counterpart of the old station, thus doubling their capacity.

THE PRIMARY BATTERY "INVENTOR" has caught this town once more, and as a consequence no less than six different companies are ready to outdo the dynamo and steam-engine.

S. C. CLUM & Co., of Philadelphia, have erected a complete electric power plant for the new lumber warehouse of Barber & Ross on 18th street. The U. S. system has been used.

WESTERN TRADE NOTES.

INTERIOR CONDUITS.—The following will give our readers a general idea of the great advancement that has been made during the past four months in the way of interior conduiting buildings for electric light wires as well as telephone and other wires, and all of which is due to the untiring endeavors of Mr. H. M. Underwood, the General Western agent of the Interior Conduit & Insulation Co., of New York. Up to July 10th the approximate number of public and office buildings for which he has made arrangements for the "interior conduit" system foots up to 22 buildings, for the distribution of about 58,105 incandescent lights. In addition to this there are five private residences which vary from 160 lights to 700 lights each, and two or three installations of concealed wires for about 150 arc lights. Two out of the above five private residences have all wires run in conduits, *i.e.*, bell, fire-alarm, etc., and one has speaking-tubes. About four of the office buildings out of the 22 have wires for telegraph, telephone, message service, etc., run in conduits, and one has the speaking-tubes.

THE ELECTRIC MERCHANDISE CO., of Chicago, through their traveling representative, Mr. D. B. Dean, have secured the order for all the overhead line material of five miles of road for the Vancouver Electric Railway and Light Co., of Vancouver, B. C. They have also received an order for six miles of overhead fixtures for the Citizens' Electric Railway, Light and Power Co., Mansfield, O., for their new equipment. Mr. D. B. Dean has sent in orders during his last Western trip for over 150 of their well-known rawhide pinions.

MR. W. R. B. WILCOX, of the Electric Merchandise Co., of Chicago, has just returned from the East, where he has been making an extended trip in the interests of the Burton electric heater, for which the Electric Merchandise Co. are the agents. This well-known heater is attracting widespread attention and interest, and especially so with reference to its introduction for heating cars on steam railroads, and it will only be a short time before it will be very generally used for this purpose.

MR. D. W. HIGGINS, president and general manager of the National Electric Tramway and Lighting Company, of Victoria, B. C., was in Chicago last week. He is looking up street railway matters and spent considerable time here with the Electric Merchandise Co.

KOHLER BROS. & GRIER, the agents for the Eddy Electric Motor Co., have just placed another 15 h. p. machine. The orders for these motors are now coming in so rapidly that they have determined to carry a stock of all standard sizes immediately, thereby enabling orders to be filled with the greatest possible promptitude.

THE ELECTRICAL SUPPLY CO. are gradually getting settled in their spacious new quarters at No. 102–104 Michigan avenue, and notwithstanding the immense amount of work involved in their change of location, they are handling their usual large amount of business with the promptitude and celerity for which they are noted.

MR. W. R. MASON, manager of the Electric Merchandise Co., of Chicago, started for New York last week on a short business trip, having some important matters regarding the Burton electric heater to attend to in the East.

KANSAS CITY NOTES.

ENGLISH, MORSE & CO., the well-known engine, belting and general machinery dealers, of Kansas City, are doing a large and prosperous business, and their business in electrical work is brisk and increasing all the while.

THE FRANKLIN ELECTRIC CO., although they have but recently started in business, are doing remarkably well. They are dealers in general electrical supplies of all kinds, and also pay especial attention to electrical construction and repair work. The promoters of the enterprise are able and energetic business men, thoroughly conversant with the requirements of the electrical trade, and at the same time thoroughly well-posted electrical engineers. Mr. W. H. Blood, Jr., was for a long time associated with the Thomson-Houston Electric Co., at Lynn; Mr. G. E. Chaflin is well known in electrical circles from his association with the Westinghouse Co., and A. M. Miller is a mechanical engineer of large and varied experience in the construction and equipment of electrical power plants.

. THE GATE CITY ELECTRIC CO., dealers in electrical supplies and agents for the famous Okonite wire and specialties, are having a good trade in all lines. Mr. W. D Greene is the manager of the company, and he is pushing the business in first-rate shape.

MR. J. W. MASON, formerly manager of the Gate City Electric Co., has now established himself at 527 Delaware street, where he is handling a general line of electric supplies for electric light, power, telephone and other work. He is also special agent for the "Safety" insulated wires and cables, which are meeting with such well-deserved success.

THOS. F. CLOHESEY, New York Life Bldg., Kansas City, electrical engineer, reports that he is handling a large amount of new electrical work and receiving numerous inquiries for propositions all the time and the outlook is very encouraging. He is interested in a new storage battery which will very shortly be manufactured in the West and placed on the market.

GRIMES BROS., 807 Main St., Kansas City, are placing on the market a new spark arrester and bug screen for arc lamps, which is being very rapidly adopted by central station men. It will be found of great use in connection with lamps as a preventive from sparks escaping and setting fire to property and keeping bugs from getting into the lamp, and its merits are well worthy of investigation.

MR. ALLEN R. FOOTE, the special Census agent for electricity, gave an entertainment recently at his residence, in Takoma Park, Washington, to twenty-four other veterans of the Civil War. The occasion celebrated the thirtieth anniversary of his enlistment as a Union Soldier. Comrade W. H. Nelson read an original poem.

A READER of THE ELECTRICAL ENGINEER in San Francisco writes: "I am thoroughly satisfied with your paper and acknowledge it as the most valuable reading matter in our profession. I shall forward you subscription for one year as soon as my trial trip runs out." Another reader in St. John, New Brunswick, writes: "It is not only keeping up its record as a leading electrical journal, but can be fairly dubbed as 100 per cent. efficiency."

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

VOL. XII. JULY 29, 1891. No. 169.

THE FRANKFORT INTERNATIONAL ELECTRICAL EXHIBITION—III.

BY

Richard O. Heinrich.

THERE are always a great many disadvantages offsetting the advantages which an electrical exhibition offers. The inventor or manufacturer, who exhibits intends to instruct the public, and to educate it to the use of new things which are to lighten the burdens of this short life. Then he wants to show to the prospective buyer and to the engineer what there is in the market; and finally he wants to go through a competitive examination with his brother inventors and manufacturers. The intentions are good enough, but only too often they remain on paper only. The general public sees an immense number of puzzles, thinks the phonograph and telephone great, the light effects beautiful, the little measuring and testing instruments "just too nice for anything" (which they often are), and finally retires, completely worn out, to a shady place where it can find the beloved brown nectar, which can be imbibed more readily than electrical science, and which goes to the spot. The scientist or engineer is just slightly better off; he can see and learn some new things, especially about the law of the conservation of energy, if he asks the exhibitor for the efficiency of his machines. Of course there is no inferior article to be found in an exhibition; every exhibitor says so, for his is the best in the world. After all, the technical public will leave with the impression that it has seen a good deal and learned very little.

But what about the poor man, who is doomed to sift good from bad and tell his confreres, who are smart enough to stay at home, all about the immense progress of the

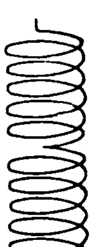


FIG. 1.

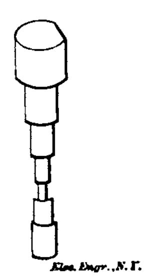


FIG. 2.

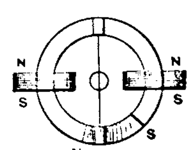


FIG. 4.

science, and about the wonderfully new and revolutionizing inventions, which the exhibitor tells him he has? The greatest advantage of such an exhibition should be found in the reports of a competent committee of judges. It is doubtful whether the work of such a committee can be very thorough, judging from the time which will be given for the purpose. The names of the gentlemen in charge, however, certainly guarantee the value of such work. It will not be too difficult to find a number of prominent experts to take charge of the different sections and to accomplish, within a reasonable time, the task, the result of which would be highly interesting to the electrical engineer and scientist. If it shall be possible to obtain some reliable data on the practical value of the continuous current transformer system, as exhibited by Lahmeyer & Co., the three-phase alternating current (Drehstrom) system, and of sundry different propositions made for long-distance transmission of electrical energy, and finally on commercial measuring instruments and electric meters, it will be all that can reasonably be expected.

FIG. 3.

FIG. 5.

Since it is to be hoped that the future will bring us some revelations on the question of dynamos and motors, I shall postpone somewhat my notes on this subject, and begin with the smaller fry, which are to be found at the north end of the exhibition grounds in the building for "Science and Electro-Medicine," and in the separate building of the Weston Electrical Instrument Company, and of Hartmann & Braun, instrument makers. This latter exhibit is one of the most complete of its kind. There are not so very many essentially new things to be seen there, but a number of improvements in their commercial measuring instruments and in some of the instruments of precision will make a more detailed account of value.

Voltmeter and Ammeter.—Externally a difference is scarcely detectable between the old and the new types of commercial meters manufactured by that firm. The voltmeter is the very same which has been introduced to some extent in America during the last four or five years. It has soft iron in its movable parts, controlled by gravity. The divisions are not proportional. The makers claim that this type of voltmeter can be used equally well for continuous and alternating currents; that the difference in the indication for continuous and alternating current does not amount to more than ½ per cent., and that the magnetic lag may be taken at 0. 6 per cent. The makers are to be congratulated on this result with soft iron, however small the quantity; but I must confess that I would rather wait until the committee of judges reports, or until I can convince myself, as I am somewhat sceptical.

The ammeters show a few radical innovations. Prominent amongst these is the controlling spring. The steel spring is wound right handed for one-half of its length and left handed for the other, as shown in the illustration, Fig. 1.

With this arrangement, it is claimed, the zero point is always constant, and change of temperature has no influence on the indication of the instrument. To this spring is fastened a soft iron core, which is drawn into a solenoid of heavy copper wire, or turned in the form of a spiral from a solid piece of copper. The soft iron core is wound of thin sheet iron, as indicated in Fig. 2. Its shape may be varied in such a way that the scale divisions are either proportional to the current, or so that the greatest space between divisions may be obtained at any desired part of the scale. The attractive force of the solenoid is considerable, 1,000 to 1,500 ampere turns. The instrument is fairly dead beat, but may have some lag, judging from the quantity of iron used, which, however, is nearly eliminated on account of the great attractive force used. The accuracy obtained for the voltmeter is 1 per cent.; that for the ammeter, 2 to 3 per cent.

FIG. 6.

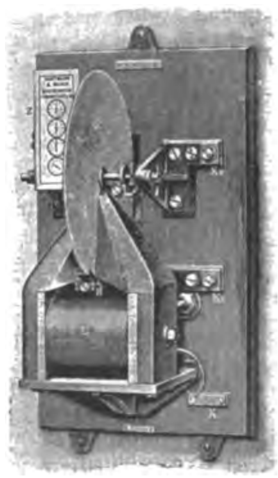


FIG. 7.

Among the instruments of quite novel construction are the torsion galvanometer and torsion watt-meter and electro-dynamometer.

The torsion galvanometer, shown in Fig. 3, is very similar to the Siemens torsion galvanometer, and answers the purpose of volt and ammeter combined. But, instead of being a zero instrument, as the Siemens torsion galvanometer is, it is made direct reading, the controlling force being a torsion spring, and the earth's magnetism partly. The movable magnet, Fig. 4, is of circular form and made of steel tubing; the two poles come near each other and are connected by a piece of soft iron to effect a magnetic circuit. The solenoids are wound in such a way that a passing current produces the polarity indicated relatively to the magnet. The position of magnet and solenoids effect a deflection proportional to the current, so that the scale is very even and direct reading. The magnet is supposed to remain reasonably permanent by means of the magnetic circuit formed.

The electro-dynamometer and wattmeter of Hartmann & Braun, shown in Fig. 5, are almost identical, except that the ring magnet is replaced by a solenoid of almost circular shape, suspended, like the magnet, by a silk fibre, the current being taken to and from the solenoid by a very fine silver spring with very wide convolutions in order to reduce the torsion. By having the stationary solenoids of low resistance in the main circuit, and the movable one of high resistance in shunt, the instrument forms a direct-reading wattmeter. The movable system is effectually clamped by large aluminum vanes. The total range of these instruments is given at 0.1 to 150 volts direct and to 1,500 with additional resistances; 0.01 to 1.5 amperes direct and 150 amperes with shunts; the wattmeter reads to about 120 watts.

The electric meters made by this firm are only designed for continuous current. In the clock meter, Fig. 6, S is a solenoid through which the main current passes and acting simply as an ampere meter with proportional deflections. Every minute the clockwork makes a contact to energize the electromagnet M, which in turn attracts the S-shaped armature. The deflected pointer of the ammeter limits the distance through which the S-armature can travel, the larger the deflection the larger the distance of the armature travelled over. When the armature is attracted the registering train commences to operate, and stops registering as soon as the limiting position of the pointer is reached; neither does it register when it goes back in its old position.

The motor meter, Fig. 7 (Wilkes' system), utilizes the reciprocal action of a current passing through a movable conductor in an intense magnetic field. The main current is taken off by means of mercury contacts from the centre to the circumference of an easily rotating copper disc. An electromagnet in shunt to the main line produces rotation of the disc when a current is passing. The eddy currents generated in the rotating copper disc produce a retardation in such a way that the number of revolutions are proportional to the strength of the current; the registering dials indicate directly in ampere hours. The whole is surrounded by a dust-proof casing. A later type has two copper discs instead of one, and the electromagnet is changed accordingly.

The clockwork meter is used up to 30 amperes, the motor meter from 50 to 1,000 amperes for any voltage required. In the beginning the meter registers somewhat too low, but is said to be strictly proportional from 15 per cent. of the total range for the old form, and from 6 per cent. up for the new type of motor meters. More exact data may be obtainable later on.

Among the galvanometers exhibited are some very sensitive and very dead-beat instruments of the Thomson astatic and of the Wiedemann type. The copper dampers employed are all very narrow, but have their greatest extension in the direction of the poles of the bell magnets, the usual form employed. This allows the coils to be brought close to the magnet, and answers the purpose of dead-beating perfectly. Among the new instruments are those illustrated in Fig. 8 and Fig. 9. The first is a dead-beat galvanometer of the Deprez-D'Arsonval type, the magnetic field being formed by a number of horseshoe magnets fastened with the same poles to common pole-pieces. The frame with the wire winding is suspended by a fine metal wire, the electrical connection being made below by a very fine wire spiral with negligible torsion. A silk fibre below keeps the coil from vibrating. Fig. 9 is a combination of a differential mirror galvanometer with a balanced reading telescope and scale.

FIG. 8.

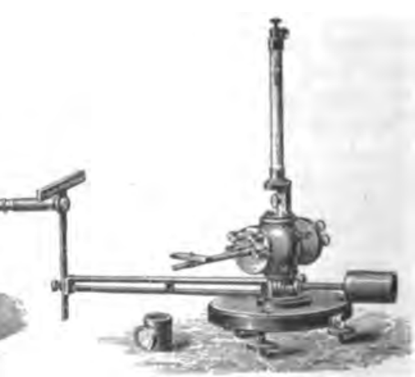


FIG. 9.

A very convenient and novel instrument for studying magnetic fields is shown in Fig. 10. A thin bismuth wire, chemically pure, is wound bifilar fashion in the shape of a spiral, and the ends brought to terminals at the handle of the instrument. The whole spiral is fastened between two small mica sheets, so that the turns are insulated from each other. This spiral serves, according to Lenard, to investigate the intensity of a magnetic field and is small enough to be introduced between the pole-piece and armature of a dynamo, being only $\frac{3}{4}$ in. in diameter and $\frac{1}{32}$ in. thick. With a change of the intensity of the magnetic field the resistance of the bismuth will be changed by a measurable amount. A change of 1,000 lines of force per square centimetre corresponds to a change of about 5 per cent. in the resistance of the spiral; a curve usually accompanies the instrument, from which the intensity may be read directly.

The exhibit of the firm showing a complete electrical testing laboratory is highly creditable. I must also mention the use by this firm of a manganese nickel-bronze for resistance instruments, which has a very small negative temperature coefficient. The time test of this alloy has not been extended enough to fully substantiate the good features claimed for this material for instruments of high precision.

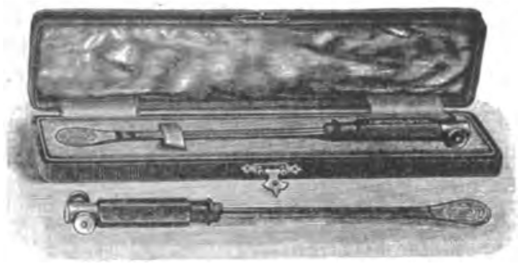


FIG. 10.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—IX.

BY

Chas. Steinmetz.

C. Dependence upon the Cross-section g, and the Length l, of the Iron Circuit, upon the Frequency N, and the Magnetic Resistance ρ.

If we increase the cross-section g, of the iron, but without changing any one of the other constants, l, r, r_1, etc., the resulting M. M. F., $\overline{OF}$, necessary for the production of the magnetism M, that is, the induced E. M. F.'s E_1 and E_1, decrease inversely proportional to g.

Hence, for increasing g, the resulting M. M. F., F, travels on $\overline{OF}$ from F in the direction to the centre point, O.

Hence the impressed M. M. F, $\overline{OK}$, decreases with increasing g, also, $\overline{KF}$ being parallel to $\overline{OA}$; and K travels towards O on the line $\overline{OK}$, or rather on the curve k, which gives the dependence of the angle of magnetic lag, $\alpha = $ KOF, upon the magnetization, OF.

This curve k may approximately, inside of certain limits of the magnetization (*not* for very low magnetization, and for magnetic saturation) be replaced by the cubic parabola, $\overline{KF} = \gamma \sqrt[3]{\overline{OF}^2} = \gamma\, \overline{OF}^{\frac{2}{3}}$, or $\overline{KF}^3 = \gamma^3\, \overline{OF}^2$, γ being the coefficient of magnetic lag.

In Fig. 17 this cubic parabola is shown, together with a true curve of magnetic lag, as found by actual tests. The magnetization used in American transformers (working with high frequency, $N =$ 100 to 140) is marked at I. The magnetization used in European transformers (working with low frequency, $N = 42$) is marked at II on the curves.

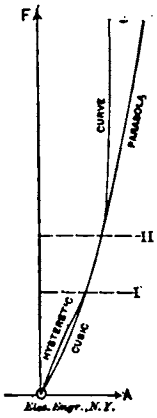


FIG. 17.

In Fig. 18, the transformer diagram is given for the iron cross-section, $g = 10$ square inches, and $g' = 20$ square inches.

As seen, the primary M. M. F., L, moves on a cubic parabola l, parallel and congruent to the cubic parabola k, and E and E_0, the primary E. M. F.'s, on cubic parabolas e and e_0, similar and proportional to the parabola k, as shown in Fig. 18. A, C, C_1, etc., are derived in the usual way.

If, as a rough approximation, we neglect the angle of magnetic lag, α, all these cubic parabolas become straight, vertical lines, as shown in Fig. 19.

The difference of phase between primary current and impressed E. M. F., decreases with increasing g, and the decrease of the "leakage current," C^{∞}, is almost inversely proportional to g. That is, an increase of g increases the efficiency, and especially the all-day efficiency of the transformer, and makes it work more economically. Hence g must be chosen as large as possible.

The length of the iron circuit, l, has an influence almost exactly opposite to g. If we neglect the variation of the magnetic susceptibility of the iron, as we have done until now, an increase of l has exactly the same effect as a proportional decrease of g. Hence a decrease of l decreases $\overline{OF}$, and thereby causes K, L, C, E, E_0, to travel on their respective cubic parabolas, which in this case are vertical lines downward, increasing the efficiency.

Hence l must be as short as possible, and it must be considered a mistake to leave a hole in the centre of ring transformers.

The specific magnetic resistance of the iron, ρ, acts somewhat similarly to l. Its decrease increases the efficiency,

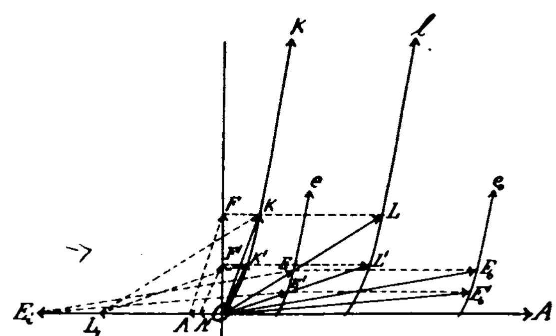


FIG. 18.

but a change of ρ means a change in the kind of iron used, and such a change also gives a different value to the coefficient of magnetic lag, γ, that is, a different angle of magnetic lag, $\alpha = $ KOF.[1]

A change of N, the number of periods per second, has the same effect as an increase of g, so that the higher the frequency, the smaller the resulting M. M. F., and the shifting of phase, and the higher the electric efficiency becomes, so far as the transformer proper is concerned. An increase of N reaches farther than an increase of g, and increases the self induction in line and machinery also, which increase of self induction may, under certain circumstances, more than counterbalance the gain in the transformer proper, the more as the loss of energy by eddy-currents increases with the square of the frequency N, and therefore, even if imperceptibly small with low frequencies, may become serious with high frequencies.

A proof of this increased loss of energy by eddy-currents is afforded by the fact, that in the transformers of Ganz & Co. in Austria, which work with 42 periods per second, the loss due to eddy-currents is negligible, while in American transformers, which work at three times as high a frequency, although these transformers are built at least as carefully as the European converters, the loss caused by eddy-currents is quite perceptible.

D. Dependence upon n and n_1.

We now consider the influence of a change of the number of turns n and n_1 of the transformer, but such a change,

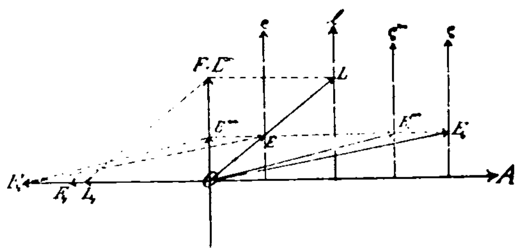


Fig. 19.

that the ratio of induced E. M. F.'s, that is $\frac{n_1}{n}$ remains the same : $\frac{n_1}{n} = \frac{3}{4} = .75$.

The other constants are again supposed to remain the same as before.

Let us, for the sake of simplicity, in Fig. 20, neglect the angle of magnetic lag. Then, for increasing n, n_1, the points L^∞, C, C^∞, E, E^∞, E_0, $E_0{}^\infty$, move downwards on vertical lines, e, e_0, etc., while L_1 moves on the horizontal line from the right to the left. L travels on a hyperbolic curve, l.

When taking into consideration the angle of magnetic lag, these vertical lines have to be replaced by cubic parabolas, as before. The ratio of transformation, $\frac{E_1}{E_0}$ approaches the limit, $\frac{n_1}{n}$ more and more, for increasing n, n_1, if the primary resistance is very small.

Especially remarkable is the rapid decrease of leakage current C^∞, and of the primary current for half-load, with

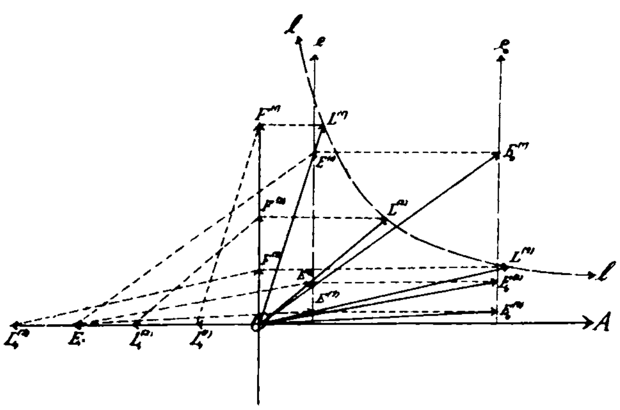


Fig 20.

an increasing number of turns n, n_1. Therefore the all-day efficiency increases very considerably with increasing number of turns n, n_1.

This fact may account for the higher all-day efficiency of some types of open circuit converters, because the much higher magnetic resistance of open circuit necessitates the use of a larger number of turns n and n_1.

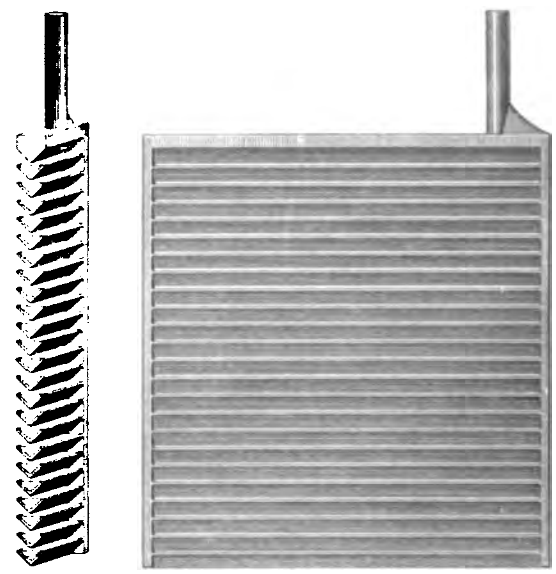
In Fig. 20 the diagrams are given for the number of turns:

1. $n = 40$, $n_1 = 30$, hence : $\frac{E_1}{E_0} = .476$.
2. $n = 80$, $n_1 = 60$, " $\frac{E_1}{E_0} = .581$.
3. $n = 160$, $n_1 = 120$, " $\frac{E_1}{E_0} = .588$.

$$\frac{n_1}{n} = \frac{3}{4} = .75.$$

THE WINKLER STORAGE BATTERY.

In addition to the dynamo and the electric car gear already described in our columns, Mr. Charles F. Winkler, of Troy, has recently brought out a type of storage battery, the construction of which, he claims, enables it to withstand the hardest usage and thus insures it a long life. The plan upon which the plate is constructed will be readily seen from accompanying illustrations, which represent respectively a section and side view of the plate.



The Winkler Storage Battery.

It will be noted that the grid consists of a vertical row of V-shaped troughs within which the active material is contained. This method of construction gives considerable area of contact and at the same time allows the active material to contract and expand without affecting the shape of the plate, and hence avoids buckling. At the same time the space between the troughs allows the liquid to circulate freely, and thus permits of a thorough utilization of the active material.

On a recent test the battery was made to give successively 40, 45, and 60 amperes at the beginning, the time being about 10 to 15 seconds in each case. For an instant the battery was short-circuited, the pointer of the amperemeter leaving the scale at 200 amperes. The battery was charged after the first discharge for 10½ hours at 10 amperes without intermission; the regular discharge was begun at 1.35 p. m., and continued at the rate of 18.5 amperes until between 6 and 6.15 p. m., when it gradually fell to 17 amperes at 6.30. After a rest of an hour the discharge started at 17.5 amperes and in 42 minutes had dropped to 14.5, when the wires were disconnected. The entire discharge amounted to 97 ampere hours, giving an efficiency for this discharge of 93 per cent. When the cell began to discharge the difference of potential was two volts, and at the end of the discharge 1.78 volts. In the cells arranged for this test the plates consisted of 5 positives and 5 negatives, and were new, having received their first or forming charge of 10 amperes for 26 hours. The following gives the weights of plate and active material:

Weight of plates alone, 16 lbs. 2 oz.

" " " with active material, 25 lbs. 6 oz.

Weight of active material, 9 lbs. 4 oz.

Where it is desired to obtain lightness, Mr. Winkler purposes to make the grids of an acid-proof, non-conducting material, such as celluloid, and to provide each of the V-shaped troughs with a metallic conductor, and to connect all the wires of one plate together so as to form the electrode. Mr. Winkler usually employs as the electrolyte in his batteries a compound of sulphuric acid, silicate of soda, and sulphate of ammonia. The compound is poured in in liquid form and after a short while congeals into a gelatinous mass, which keeps the plates firmly in place and at the same time avoids the spilling of the liquid, which might occur when the batteries are used for traction purposes.

THE NEW BOSTON TELEPHONE EXCHANGE.

The inadequacy of the facilities for their constantly growing business in Boston some time ago forced upon the New England Telephone and Telegraph Co., the necessity of enlarging their central exchange and they determined to erect a building specially adapted to the wants of a telephone exchange and equipped with the most modern apparatus. After careful and minute planning this building was begun, and on July 11 the old exchange was transferred to the new without the slighest interruption of services.

The new exchange is situated in the new building of the American Bell Telephone Co., at the corner of Milk and Oliver Streets, which occupies a lot 90×100 feet. The building is nine stories high with an additional story of smaller dimensions than those below. The building is constructed of brown brick and Scotch brown sandstone, and is of fireproof construction throughout, so that should a fire originate in any of its apartments it could not spread or do any damage beyond that place.

Of the nine stories, the lower five will be rented for business purposes. Upon the sixth are the executive offices of the American Bell Telephone Company, as well as the treasurer's office, and the office of the legal department. Upon the seventh floor are the offices of the electrical and patent departments, the archives, and the offices of the auditing and statistical departments. The eighth floor is occupied by the business offices of the New England Telephone and Telegraph Company, consisting of the general executive offices, the office of the Boston division, the treasurer's department, and the offices of the electrician, engineers, and the auditor and secretary. The ninth story, and the small tenth story already mentioned, are entirely occupied by the operating department. The corridor floors are all laid in mosaic, and the dado work is of the finest polished marble.

The basement contains the heating and ventilating apparatus, the dynamos for the electric lights with which the entire building is equipped, and the elevator machinery, beside affording storage room for the supplies of the New England Company. The electric light plant is one of the most compact and complete of its kind to be found anywhere. The steam plant, from which the power is derived, consists of a battery of two Whittier Machine Company's boilers of 55 h. p. each. There are two high-speed Ide engines of 70 and 40 h. p., respectively and two Western Electric Company's incandescent light dynamos, one with a capacity for generating current for 500 lights, and the other for 800 lights.

One of the most prominent features of the building and equipment is the conduit and cable system employed. All the wires enter the building through underground cables. From the Milk street conduit there are 50 ducts that enter the subway, each duct capable of accommodating a cable carrying 120 wires. At the corner of Milk and Oliver streets what is known as the State street conduit enters the subway. This has 27 ducts for cables. On the Oliver street side, near the south end of the building, the Oliver street conduits are reached. These have 70 ducts, of like cable capacity with the others.

The subway is lined on either side and overhead with iron racks on which are hung brackets to support the cables entering the buliding from the various conduits. Not only this, but under the concrete flooring of the subways there are a number of ducts which are employed for the same purpose. All the cables received into this subway are carried to or converge into the cable shaft at the south end of the building. This shaft is 5x10 feet in area, and is carried up from the basement to the ninth story, a distance of over 100 feet, between solid brick walls, where the various wires which are comprised in the cables are connected with the switchboard apparatus of the operating room.

The ninth floor of the building, a plan of which is shown in Fig. 1, is entirely given over to the operating department. The cables carrying the lines come from the ducts in the street up through the shaft provided, as stated, specially for them in the body of the building, and enter the distributing room, part running through ducts in the walls

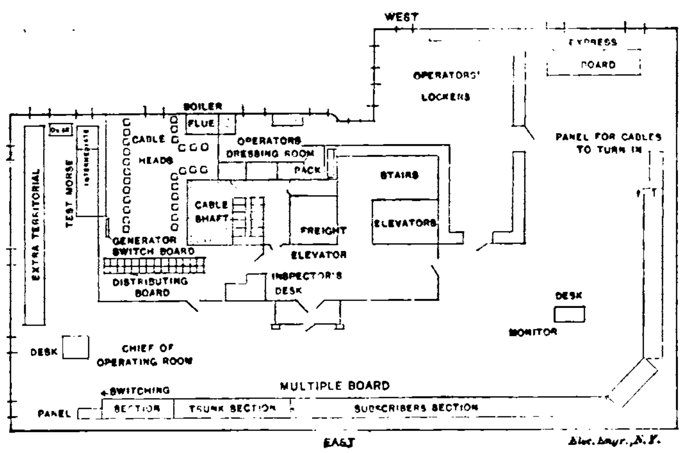


FIG. 1.—PLAN SHOWING ARRANGEMENT OF MAIN OPERATING ROOM.

near the floor to the lower row of cable heads, and part through ducts in the ceiling to the upper row of cable heads. They are so arranged that they do not cross each other in any part of their course, so that any cable may be removed and replaced without disturbing any other cable.

The cable heads are in two rows, an upper and lower one, mounted on an iron framework placed a few feet from the walls of the room, so that the cable heads and the protectors may be accessible from both the front and the back, Each conductor in the cable ends in a binding post insulated from the iron of the cable head. From each binding post an okonite-covered wire runs to a Hayes combination strong-current protector which protects the switch apparatus from both strong and weak currents. From the protector, each circuit passes through a cable under the flooring to the outer terminals of the distributing or cross-board (shown in Fig. 1) which is of the latest Hibbard pattern, built of iron rods and tubing, and arranged so that in one division the wires shall be carried in a vertical direction and in a second division behind the first, so that they shall be carried in a horizontal plane.

The distributing board is 15½ feet long, 2½ feet wide and 9 feet high, has an ultimate capacity of 6,400 pairs, and is provided with a platform under which the wires come from the cable heads and run to the switchboards. At present the board is not wired to its full capacity, the terminals at one end being used for wires leading to extra-territorial apparatus, and at the other for wires leading to the local subscribers' apparatus, the space in the middle being left for future growth. To the inner terminals of the distributing board are connected the conductors running to the switchboards.

In describing the switchboards, it will be best to begin at the extreme right and describe the board in turn to the extreme left.

On the extreme right is a test and combination loop-board (Test, Morse, Fig. 1) with capacity for 1,020 telephone wires and 102 combination loops. The test-board is for the purpose of locating troubles by testing lines and for interchanging lines. At the board, the Circuit Manager, provided with telegraph and telephone instruments and galvanometer and rheostat, tests every line every morning, and gives orders to his men and the different managers to remove trouble located by him in their territory. The combination loop-board is for the purpose of handling combination loops.

Next to the Combination-Board is placed the Intermediate Switchboard (Intermediate, Fig. 1), having an ultimate capacity of one hundered and fifty pairs of wires for long-distance subscribers and ninety local trunk lines for connecting extra-territorial boards together. The eight Extra-Territorial Boards (Ex-Territorial, Fig. 1) are situated on the other side of the alcove. At these boards the extra-territorial and long-distance work is carried on. The regular multiple-board situated on the east and north side of the room takes the local subscribers', grounded and metallic, and suburban trunk lines. The board is made to grow from right to left and is built with an ultimate capacity of 6,000 subscribers' lines and 600 trunk lines, and is at present wired for 3,600 subscribers and 300 trunk lines. It is at this board that all the local exchange and suburban trunk-line connections are made and that the local subscribers are connected to the Long-Distance boards for ex-territorial business.

On the extreme right of this board is the extra-territorial switching section, provided with an end section on each

FIG. 2.—MULTIPLE SWITCH BOARD AND CHIEF OPERATOR'S DESK.

side for the convenience of the operators on the regular sections (Switching Section, Fig. 1). There are four operators on this section ; one connects the subscribers on the multiple board to the extra-territorial boards, two connect the extra-territorial boards to the regular multiple subscribers' board, and the fourth operator makes connections between suburban trunks.

Next in order come the trunk sections where all the suburban trunk lines end (Trunk Section, Fig. 1). These lines first multiple through the board and then come back to the trunk section to the drops and end in a double cord. There are three sections of trunk lines, a hundred lines to a section, and three operators to a section. At the left of the trunk sections are the fifteen subscribers' sections, shown in Fig. 2, with three operators to a section and eighty subscribers to an operator, and showing the Chief Operator's desk.

To each operator's telephone set, a circuit runs to the Monitor's Desk (Monitor, Fig. 1), and shown in perspective in Fig. 3; the monitor may cut in and hear if any impoliteness is being shown either to, or by, a subscriber.

The express board situated across the end of the room (Express Board, Fig. 1) on the extreme left of the board is for handling the express business. This express service is peculiar to Boston. There are six hundred subscribers for this service which consists only of calling expresses. No connections are made; the subscriber simply gives the order to the operator through a hand telephone. The

FIG. 3.—MULTIPLE BOARD AND MONITOR'S DESK, BOTH WITH CONNECTIONS UP.

operator puts the order on a slip and hands the slip across the board to the sending side. The operators on the sending side sort the slips and call up the different express companies and deliver the orders.

The drops on the regular multiple board are all placed in a trough to economize space, and the board is provided with an intermediate distributing board for interchanging the circuits between the multiple and the answering jacks. The drops on the intermediate board, the extra-territorial board and the express board are on the face of the board.

The battery and generator rooms are in the tenth story, a half story, to which the freight elevator runs. Three hundred cells of gravity battery will be placed in these rooms for the circuit manager's instruments and the busy test, etc.

The transmitters on the boards will all get their battery power from a four-cell accumulator which takes the place of 250 gravity cells. This accumulator is charged by a special dynamo run by a motor which gets its power from the regular lighting circuit. The 12 metallic circuit generators are run by the same motor that drives the accumulator dynamo. The generator circuits are provided with a switchboard of the cross-bars and pins pattern by means of which the circuits are interchanged and manipulated with perfect ease. The battery circuits to the different operators' sets are provided with fuses to protect the instruments from overcharge from the accumulators.

The engraving Fig. 4, shows the back of the board, exhibiting the cabling and iron and wood supports, the back of the cord shelf and the intermediate distributing board.

Three competent switchboard inspectors are constantly employed in testing and keeping in order the wires of the switchboard, the extent of which can be judged from the fact that the number of soldered wire connections in it are 448,856, and the number of feet of copper wire 14,943,868, or 2,745 miles of wire, all in comparatively short pieces. There are 133,126 distinct moving parts in the switchboard apparatus, and this only includes such separate pieces as are capable of being moved and require to be moved in position in the regular operation of the board.

The photographs from which our illustrations are made are the work of Mr. Willard Vandelip, of the engineering department of the New England Telephone and Telegraph Co.

While the general work connected with removal of the exchange was carried on under the supervision of General Manager J. M. Keller and his assistant, Mr. W. J. Denver, who has immediate charge of the Boston division of the company's business, the laying out of the routes of the cable conduits and supervision of all the underground work was in charge of Mr. Clarence J. Perkins, the

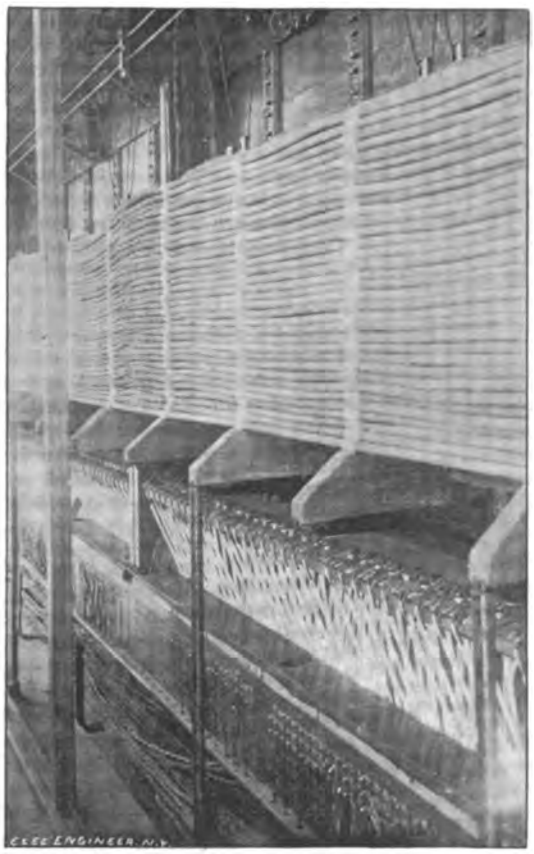


FIG. 4.—BACK OF SWITCH BOARD, SHOWING CABLING, SUPPORTS, CORD SHELF AND INTERMEDIATE DISTRIBUTING BOARD.

engineer of the company. The details of the electrical work, including the switchboard and its connections, were made under the direction of Mr. I. H. Farnham, the company's electrician.

The officers of the New England Telephone and Telegraph Company are: Thomas Sherwin, president; Henry S. Hyde, of Springfield, vice-president; S. W. Leedom, auditor and secretary; William R. Driver, treasurer; F. A. Houston, attorney; J. M. Keller, general manager; W. J. Denver, assistant general manager; I. H. Farnham, electrician, and C. A. Perkins, engineer.

REPLACING PLATINUM IN INCANDESCET LAMPS.

Word comes from Vienna that a Capt. Walter has discovered a method of amalgamating glass with other metals besides platinum, enabling manufacturers of electric lamps to make them at a cost much less than at present. The platinum wire used in the construction of the bulb is expensive, but it has nearly the same rate of expansion as glass. Changes of temperature cause both to change bulk at nearly the same rate, so that if the platinum wire once fills the holes through the glass it always does so, and thus prevents the inrush of air, which would be fatal to the life of the carbon filament. Reports have been current of similiar advances here, notably by an inventor at Louisville, Ky.

ADVANCES IN ELECTRIC HEATING.

BY

W. H. Mullen.

THE practicability of electrical heating has recently been receiving its conclusive demonstration. The time has come when apartments, wherever situated, on land or sea, moving or stationary, may be warmed by electricity. The uses to which electrical heaters may be put are far more numerous than those persons not interested in that particular branch of the electrical industry appreciate. The wide range of their usefulness comes home, perhaps, more forcibly to those engaged in the work of their commercial distribution. Hints, propositions, happy suggestions, incidentally remarked, bring forth delightful pictures of comfort, which, like good architects' sketches of some proposed edifice, are accurate representations of what is to be.

The thought that all the useful effects of combustion, as employed for the comfort of man, may by a slender wire be brought into our homes, thereby doing away with the customary periodical transportation of fuel, while at the same time all the disagreeable and even dangerous products of combustion, such as smoke, gas, and flame, are carried away a hundred feet above our heads by the tall chimneys of some power house, itself, perhaps, many miles distant, has no inconsiderable charm.

In any electrically heated house, the absence of clumsy heat and smoke conveying apparatus is noticeable, and in May, the month of universal house-cleaning, it would be still more noticeable, for no soot can be shaken from a No. 16 copper wire. In warm weather the electric heaters take the place of gas and oil burners for doing small cooking. Without the disagreeable dirt and odor of the latter, they perform within a few minutes such services as boiling an egg, warming a cup of tea or coffee, toasting crackers or bread. Put to this use upon train or shipboard, the results are especially pleasant. While at all times abundant warmth may be obtained from electrical heaters, they furnish, when desired, less warmth than those in present use. Thus upon cool spring and autumn evenings, when it is not cold enough for a fire in a furnace or stove, yet is disagreeably chilly, they render a delightful service. There is no arranging of fuel, regulating of draughts, or removing of ashes. Within a few minutes after the simple act of turning a switch is performed the chill disappears from the air. The heaters occupy but little space and may be formed into more shapes than stoves and other heating appliances at the present time.

What the incandescent lamp is to artificial lighting, the electrical heater is to artificial heating. As are the lamps, so will the heaters be distributed over the walls of our theatres and concert halls, shedding their warmth uniformly throughout the room as the former do their light, forming, it may be, the panels in some elaborate wainscoting or included in some ornamentation; they may not only provide warmth for our bodies, but also be the cause for the removal of the cumbersome, inartistic radiators, registers and steam pipes, which are forever obtruding themselves upon our vision. In general use, their safety, neatness, and labor-saving qualities recommend them to all who have at hand the electric current or convenient means for generating the same. It is not unreasonable to predict that by the time the idea of electric heating is as old as that of electric lighting or of electric traction, power stations for that particular purpose will also be erected.

While in such stations where the power is derived from steam engines, the expense of the heaters connected therewith may be somewhat in excess of that of coal, oil, or gas heaters, still that excess is no more than a just price for the increased convenience and comfort received therefrom. But in many places water-power is utilized for dynamo work. In such localities people easily recognize the economy of heating by electricity, and especially is this so when in those same districts the cost of fuel is great. Thus the Canadians, with whom the price of coal is high, while swift-running streams provide abundant mechanical power, are anticipating with enthusiasm the installation of power stations for supplying the adjoining territory with current solely for heating purposes.

Nearly all ocean steamships now are equipped with apparatus for electric lighting. Within a few years their dynamo capacity will be increased so that they may provide heat as well as light. One system of wiring will then perform the combined work of conveying light and heat and the necessity for the present expensive and difficult system of steam conductors will no longer exist.

There is, however, a more urgent necessity for electrical heaters in the railway world. Electric roads, such as traverse the streets of our cities, are beginning to utilize the means so convenient for them of heating their cars. With them, not only the actual cost of heating is reduced, but the incidental expense of caring for stoves and fuel on the cars is entirely removed. The greatest boon, however, will accrue by their use upon steam roads. Already there are roads taking active measures to place them upon their trains. A prominent representative of America's leading trunk line remarked a few days since that stoves and steam for heating purposes must give place to electricity, if the latter proved at all practicable. Railroad men realize that accidents are in some cases unavoidable; that their evil, at best, is great; but it will be appreciably lessened when the danger of death by burning or scalding is removed. The time is not remote, we believe, when a dynamo car will be as necessary an appendage to a train as the tender. It will contain one or more electric generators with accompanying steam plant. In fact, it will be a power station complete in every respect, having its own separate attendant.

Thus does the electrical heater bring to us increased convenience and comfort, cleaniness and safety. And it is not by great expenditure that this improved condition of affairs may only be secured. A foreign journal of recent issue contains the remark that the one obstacle in the way of the early introduction of electrical heaters into everyday use is their excessive expense. No greater obstacle can present itself than the reiteration of such erroneous statements. Both by repeated experiments and by actual service their economy has been proven. Of novelities people are suspicious. Unless complete success attend their first appearance they wrongfully are considered failures. However, the electrical heater, like all meritorious inventions, will survive such thoughtless suspicions, and even now includes itself among our economical modern improvements.

THE FATIGUE OF METALS.

WITH respect to statements that occasionally appear on the subject of the fatigue of metals under long-continued stress, a report that has recently been published regarding two similar suspension-bridge links is worthy of notice. A square iron link, 12 inches wide, 1 inch thick, and about 12 feet long, was taken from a bridge at Kieff, then about 40 years old, and tested against a similar link which had lain unused in store ever since the building of the bridge. The means of comparison were, therefore, excellent, and the result should go a long way to show whether or not iron really does lose any of its strength in prolonged service. The effect of the tests was to determine for the old used link an ultimate tensile strength of 21.8 tons per square inch, an elastic limit of 11.1 tons per square inch, an elongation of 14.05 per cent., and a contraction of 17.35 per cent. at the point of fracture. For the unused link, the tensile strength was found to be 22.2 tons per square inch, with an elastic limit of 11.9 tons, and elongation and contraction at fracture of 18.42 per cent. and 18.75 per cent. respectively. The two pieces of iron were, therefore, of practically identical strength; for the small difference actually observed is well within the ordinary range of variability of similar pieces of the same metal.

ELECTRICAL DEVELOPMENT IN THE SANDWICH ISLANDS.

BY

Jno Cassidy

As far as I am aware, little or nothing has ever been said about electrical development in the Sandwich Islands. I will therefore venture to tell the readers of THE ELECTRICAL ENGINEER, which is very well known in this part of the globe, what we have, what is needed, and what could be supplied with profit from the United States.

The Sandwich Islands are famous for their beautiful water-powers, and this power is being utilized for electrical work. The streets of Honolulu are lighted by 92 arc lights of 2,000 c. p. of the Thomson-Houston system, and the dynamos are driven by water-power. The same station furnishes 800 incandescent lights for residences and stores. This plant is the property of the Hawaiian Government. The Queen's Palace has a private plant of one Armington and Sims engine and two Thomson-Houston low-tension dynamos with a capacity of 600 lights. The Honolulu Iron Works have a plant of 75 lights, operated by a Mather incandescent dynamo. The Union Iron Works have an Edison plant of 75 lights. This enterprising concern have a Thomson-Houston motor in their pattern shop, and have now ordered a welding machine. The Oahu Railway has a private plant. The Waianae Plantation runs an arc system, not only out in the cane pieces but in the sugar mill. Nearly all the island steamers are furnished with electric light plants, annunciators, &c. The residences of planters on the other islands are also well supplied with the electric light.

Besides this, Mr. James Campbell, a wealthy land-owner, has installed at his Wikiki residence an accumulator plant furnished by the Edco Co., of Philadelphia; and Mr. Wilder, of the Wilder Steamship Co., has an accumulator plant at his residence. This is not a bad showing for the electric light.

The telephone industry is also in good condition. Honolulu itself has a population of 22,000 and a telephone system of 1,200 subscribers. On the island of Hawaii there are two telephone companies—the Hawaii Telephone Co. and the Hilo Telephone Co. The Maui Telephone Co. is on the island of Maui, and the Kaui Telephone Co. is on the island of Kaui. The telephones in use are from the American Bell Telephone Co., of Boston. The large plantations have also extensive private telephone service of their own. All telephone instruments and material are free of duty when entered by the company itself, giving the company an advantage over the merchants in the importation of electrical goods. Copper wire is extensively used in the construction of telephone lines, because of the salt air. A No. 12 iron wire circuit 9 miles long has been known to fall to pieces in less than two years, owing to the chemical action of salt water spraying on the galvanized iron.

There is also a general use of the telegraph in the island, and one hears a great deal about submarine cables between the Sandwich Islands and the American Continent. The great need of the kingdom is inter-island cable communication.

I might add that THE ELECTRICAL ENGINEER, with its well-filled pages of electrical knowledge, news and advertisements, is a familiar periodical, found on every island of the group, in the workshop and the plantation, in government offices and in the importing houses of merchants, through whose agencies a large quantity of electrical goods is imported.

THE NEW MATHER MOTORS AND POWER GENERATORS.

RECOGNIZING the demand for power transmission by means of the electric current, the Mather Electric Company has brought out a series of machines for that purpose which, while embodying the essential features of the well-known Gramme ring type, can be more readily insulated against the high potentials required for power service.

One of the essential features of the old type of Mather machines was a field magnet having the form approximately of the magnetic lines of force and consisting of one piece. In the new type the cores of the field magnet are straight, permitting the use of coils of wire that can be wound separately on a machine, while the rest of the magnetic circuit is practically a ring, and the whole, including the cores and pole-pieces, is cast in one piece without a joint.

The motors are built in sizes of 1, 3, 6, and 10 h. p. with two poles, and 20, 30, and 40 h. p. with four poles.

The generators are built up to 30,000, 50,000, and 75,000 watts with four poles, and 180,000 watts with six poles. Drum armatures are used in all the machines. In the four-pole machines the winding is such that the current has but two paths through the armature wires, and by a special method, devised by Prof. Anthony, no two wires having any great difference of potential are brought near each other.

The engraving, Fig. 1, which represents the 75,000-watt generator, shows the general character of all the four-pole machines, with the field magnet in one casting. In the 180,000-watt six-pole machine the field magnet is cast in two halves, but divided through the middle of two opposite poles instead of across the magnetic circuit.

The engraving, Fig. 2, shows the two-pole form adopted for motors up to 10 h. p. These small motors are wound and kept in stock for 220 volts, but can easily be wound for 110 or 500 volts, when desired. The winding is such that in no case is there a loss in the armature of more than four per cent., and the speeds run from 1,500 revolutions for the 10 h. p. to 2,500 for the 1 h. p. The variation in speed from full load to no load is never more than four per cent.

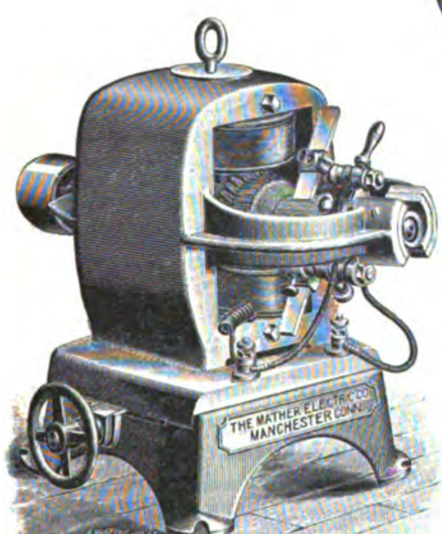


FIG. 2.—NEW MATHER MOTOR.

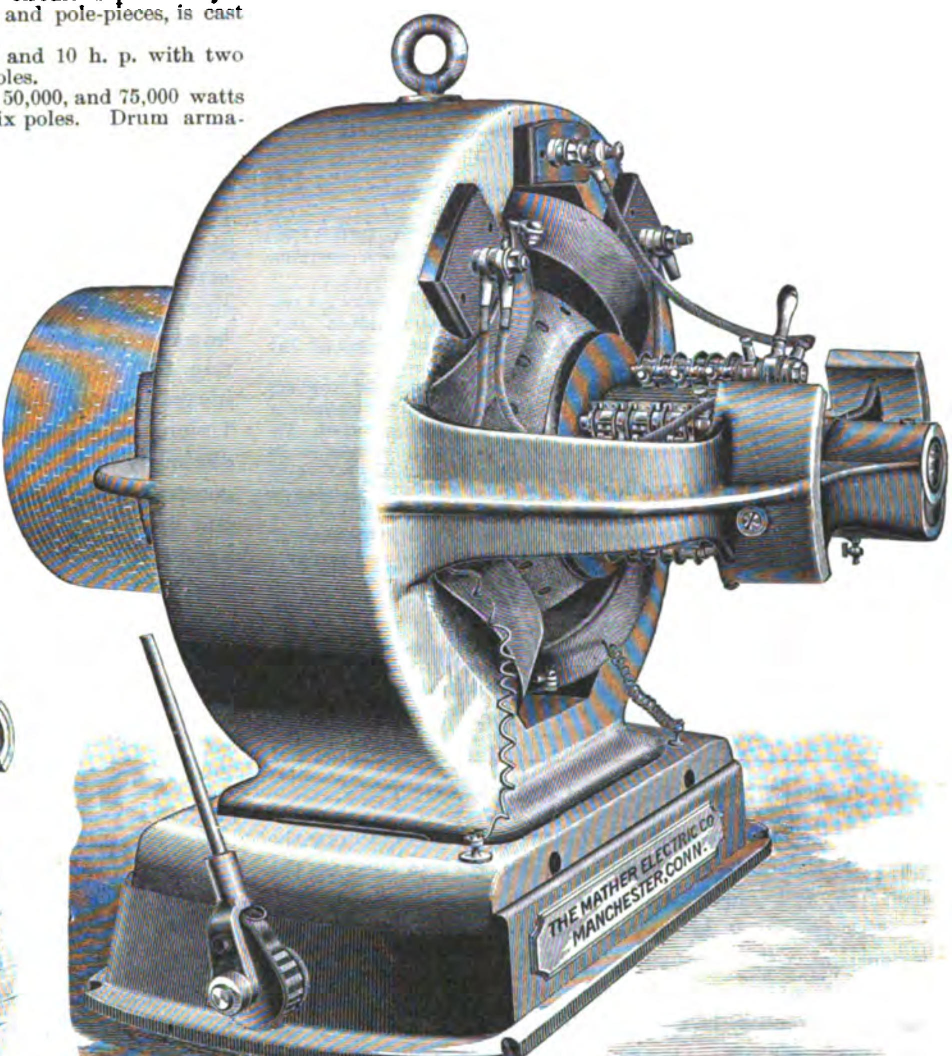


FIG. 1.—NEW MATHER 75,000 WATT GENERATOR.

CONSTRUCTION OF NON-INDUCTIVE RESISTANCES.

PROFESSOR AYRTON and Mr. Mather at the last meeting of the Physical Society presented a paper, says our London correspondent, on the construction of non-inductive resistances. In making some transformer tests about three years ago, the authors had occasion to consider the construction of electric conductors, the impedances of which should be practically equal to their resistances. This condition could only be fulfilled by making the inductance small in comparison with the resistance, and as the former does not depend on the material employed (excepting iron), it was important to use substances of high specific resistance. Carbon or platinoid being available, the latter was chosen on account of its low temperature coefficient. One form of resistance exhibited consisted of strips of thin sheet platinoid about 6 metres long and 4 centimetres wide. Each was bent at the middle and doubled back on itself, thin silk being placed between the contiguous parts, and narrow ribbon used to bind the parts together. Twelve such strips arranged in series had a resistance of 2.95 ohms, and would carry a current of 15 amperes without changing its resistance more than $\frac{1}{10}$ per cent. This strip resistance was made by Messrs. C. G. Lamb and E. W. Smith, who at the time were students in the Central Institution. Another form of resistance designed for portability consisted of bare-wire spirals, each length having a left-handed spiral placed within a right-handed one of slightly larger diameter, and the two being connected in parallel. This device was found to reduce the inductance to $\frac{1}{10}$ or $\frac{1}{20}$ of that of a single spiral, according as the diameters of the spirals approach towards equality. When the spirals are made of platinoid wire the ratio of inductance to resistance is very small, averaging about $\frac{1}{500000}$.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XII. NEW YORK, JULY 29, 1891. No. 169.

It is not alone to the actual inventions which have been made under the stimulus of the patent law that we must look for the fruits of that law; it is also to the power which has been acquired to make future inventions, to the patience and skill and intelligence which have been developed.—Chauncey Smith.

THE INCANDESCENT LAMP SITUATION.

WHILE the decision of Judge Wallace sustaining the Edison lamp patent has done much to clear up the situation, and must be looked upon as an award of substantial justice, it is easy to see from the proceedings in connection with the settlement of the decree that Judge Wallace himself entertains very fully the views that we set forth last week as to the desirability of moderation on the part of the victors. Our report in another column of what transpired shows him to believe that not a little consideration is due the vanquished, and that as far as he is concerned they are likely to get it.

Two expressions of opinion on the part of the court are very striking. As to the temptation to innocent, or even justfiable, infringement, it said: "The greatest cloud that hung over the patent was in its claims—in the language of the patent itself. *He did not much blame any infringer for assuming that he could go on and make any sort of an incandescent lamp without fear of that patent.*" Elsewhere, criticising the delay in testing the validity of the patent, as against infringement, Judge Wallace remarked: "What had influenced him very much * * * was the circumstance that there had been a long delay in the prosecution of the suit and the additional circumstance that the patent was one very well calculated to engender doubt in the minds of people who were making lamps as to whether it was good for anything, and then there was the fact that during this time a large amount of capital had been invested and a great many men were employed in making the lamps." Such language coming from the judge who has himself sustained the patent is, to us, most significant as an intimation of what he thinks should be done in the premises.

Unfortunately there are grave and serious difficulties in the way of such a settlement as we would like to see arrived at between the holders of the patent and other manufacturers of lamps. These difficulties consist chiefly in the fact that the Edison General Electric Co. has formal contracts with some seventy large sub-companies or licensees, giving them the sole right to the use of Edison apparatus in their respective territories. These territories, so far as we are informed, comprise most of the choice lighting area in this country, and evidently under this decision, these local companies inherit what can only be described as a "bonanza." It is a vested right of a very desirable character for them, and it is only natural and to be expected that they should seek to conserve and maintain that which would give them the virtual monopoly of incandescent lighting in the large towns and cities of the Union. We state the case broadly, because the point is obviously most important, and no one could blame local companies for trying to get the benefit of their contracts and investments. Local companies of whatever system have rights, and we are only sorry to say that parent companies in their "deals" have but too often forgotten the claims that their licensees had on them. Still, we are fain to believe that a wise and skillful policy will find a way out of the difficulties hinted at, and which certainly exist; and we must put on record our conviction that such a *modus vivendi* for the remaining two years of the patent ought at once to be sought for and found.

THE STORAGE BATTERY DECISION.

THE decision by Judge Coxe sustaining the patent of Mr. C. F. Brush on the employment of an active material mechanically applied to a storage battery plate, and thus reaffirming his former decision in a suit of like character, might reasonably have been expected, as the present case differed but slightly from that decided in Mr. Brush's favor as against the Julien Company. Judge Coxe's decision, however, contains a number of points which the inventor and intending patentee cannot too strongly impress on his mind. For instance, he emphasizes the care required in the drawing not only of the claims, but of the specification. Thus he alludes to the wording of the patent as being unnecessarily prolix and calculated to confuse the electrician as well as the lawyer, and hence introducing an element of doubt which might in some cases militate against the proper appreciation of the scope of the patent and its judicial construction. As he remarks, the ringing of changes upon a few given elements and the coining of new phrases and words do not constitute invention as contemplated in the patent law. While granting broadly to Mr. Brush the application of active material to the plate, Judge Coxe decides that there was no invention in the application of red lead in view of the fact that red lead is a form of oxide of lead, and, according to the inventor himself, an inferior material. The decision dwells at length upon the Italian patent granted to Mr. Brush, in which he describes a particular form of storage battery, and which, having expired, was brought forward as an argument for the expiration of the American patent. Setting on one side the recent decision of the Supreme Court on this point, Judge Coxe takes the view that the Italian patent was not intended to cover the same points as those claimed in the American patent, and hence he gives to the latter the broad character contended for it. Throughout the decision it is evident, and is so expressed, that the Court was disposed to give Mr. Brush the benefit of any doubts, and this action appears to be in keeping with a practice now becoming general in this respect. The same action can be traced in the recent decision of Judge Wallace in the Edison filament suit, and is, we are glad to believe, an indication that our courts are willing to protect an inventor in his rights independent of small "technicalities." It is to be hoped that this decision may finally place the storage battery in such a position that its commercial exploitation will no longer be retarded, as it certainly has been in the past, by the fear of legal complication arising to the user. Indeed, indications are not wanting to show that this will be the case in the immediate future.

A NEW PHASE OF ALTERNATING CURRENT LITIGATION.

Appearances indicate that the last word has by no means been said on the question of controlling patents in the alternate current system of distribution. A very general impression has prevailed in electrical circles that this matter was practically settled by the defeat of the Westinghouse Company's Gaulard and Gibbs patent, in the suit brought under it against the Sun Company, of Woburn, Mass., and decided by Judge Colt in 1888. In this case, it was in substance held that at the date of the patent there could have been no invention in the employment for a different purpose of a known variety of converter which transferred energy from high to low potential as distinguished from a conversion from low to high, but that something further was required to solve the problem of a successful system of electric distribution; that the Gaulard-Gibbs patent was limited to an organization for distribution in which the converters were arranged in series, and hence that the defendant, which used a multiple-arc arrangement, did not infringe. Now it appears that the Westinghouse company did not place their sole reliance on the Gaulard-Gibbs patent, but had also taken the precaution to secure Kennedy's invention of 1883, based on his discovery of the self-regulating properties of converters when arranged in multiple-arc, which was patented in this country in 1889. This patent, which we reprint in another column, is the one on which the Westinghouse Company has now brought suit against a local electric lighting company in Vermont, as mentioned in our legal notes a few weeks ago. The Kennedy patent covers in terms the essential principle of arranging converters in multiple arc, the only method, so far as we now know, of any great practical value; and in view of the language of Judge Colt's decision in the Sun case, it can hardly fail to be held to be a patentable invention. It would seem, therefore, that the issues involved in this latest suit are scarcely less important to electric lighting interests than those presented in the incandescent lamp case.

ELECTRIC POWER DATA.

American trade catalogues and publications have long since acquired a reputation not only for their typographical excellence and the beauty of their illustrations, but also for the large amount of valuable information which they contain and which not infrequently makes these publications a valuable treatise on the state of the art to which they appertain. This is, we think, specially applicable to the publications in the electrical trades, and we have on more than one occasion found space for their extended notice. That the value of such work is becoming more and more recognized is evidenced by the fact of its continuance, and two recent publications of this nature which have reached us, deserve, we think, special notice. The subject of power transmission by stationary motors, and for electric railway work, has now reached an importance second not even to that of electric lighting, and hence data on these two subjects, especially if of a practical, commercial character, will be welcomed by many. In the former domain, a recent publication of the C. & C. Electric Motor Co., from which we give copious extracts on another page, presents an excellent résumé on a question which has from the beginning given rise to much thought on the part of station managers. The proper basis of charge for the power supplied by electric motors must of necessity vary somewhat with the local conditions, but where these conditions are alike, the experience of one station will be an excellent guide for others who contemplate undertaking this class of work. The variety of methods offered as a basis, as well as the variety in character of the work of the motor, are excellently shown, and in this connection we would again call attention to the excellent paper by Mr. Lufkin read before the National Electric Light Association at Cape May in August, 1890, entitled "A Proper Basis for Determining Electric Motor Rates." The discussion of the relative merits of constant potential and constant current circuits also brings into strong relief the advantages of the former, but the existence of many continuous current circuits which now remain idle in daytime would make it appear that notwithstanding the objection cited, there is some room for a profitable utilization of this method of transmission in many cases where power distribution has not yet been attempted and where it can be done with practically little investment for new wires.

The data on electric railway work, compiled by the Field Engineering Company, gives an excellent idea of the cost of installation of such roads. It also brings out prominently the relative cost and economy of the high-speed and low-speed engine, as well as the single, compound and condensing engine, showing that in this respect too great care in the designing of a station cannot be exercised. Where the general information on all points connected with power distribution is still so meagre, such publications as those above mentioned are not only of value from the technical standpoint, but they indicate clearly the fact that the industry, as a whole, is now so well established that exact data is forthcoming, and that calculations based upon it can be relied upon in commercial enterprises.

ON THE MECHANICAL ACTION OF ELECTRICAL WAVES PROPAGATED IN CONDUCTORS.[1]

BY H. HERTZ.

AFTER studying various forms of apparatus to determine the forces to which a conductor is subjected when placed in the path of a series of electrical waves, and obtaining results that were quite concordant in respect to the points at issue, I adopted that used by Mr. Lecher, and shown in Fig. 1. Here A A' is the primary conductor, formed of two square plates of 40 centimetres side, joined by a brass wire 60 centimetres long. This wire is interrupted in the middle of its length, where the spark gap is placed. A small induction coil is used as exciter, worked by two accumulators, and producing sparks four centimetres long. The

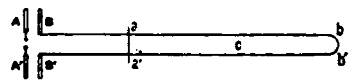


FIG. 1.

simple discharge of this little coil is certainly less powerful than that of a larger one, but the rapidity of the discharges compensates for the defect.

Facing the plates A A', at a distance of 10 centimetres, are the plates B B' attached to two parallel wires B *b*, B' *b'*, placed at 10 centimetres from each other. These wires are each 6.8 meters long, and their ends are connected at *b b'*. At a distance B *a*, which is variable, the two wires are also connected by a bridge piece *a a'*. For a certain position of this bridge, at a distance of about 1.2 metres from B B', a very energetic oscillation is produced at *a a'* and *b b'*. This represents the half length of a stationary wave, and, as Mr. Lecher has shown, it is produced by resonance between this vibration itself and the primary vibration produced in the air, between A A' on the one side and B *a a'* B' on the other. A displacement of the bridge augments the period of one of these vibrations, and at the same time diminishes that of the other, so that with this arrangement the proper position of the bridge is determined in a very precise way.

The forces to be observed being small, all extraneous electrostatic actions due to the presence of conductors must be carefully eliminated, which may be readily accomplished with this apparatus, as the wires form a system of continuous conductors. If, in our experiments, the active parts be surrounded by a metallic cage connected with the nodal points, *a a'* and *b b'*, they will be still more completely protected without altering their vibrations. The vibration is of the same character, independently of the form or position of the two wires.

For the measurement of the mechanical action of the electric force, I have used a little cylindrical tube of gilt paper 5.5 centimetres long, and 0.7 centimetres in diameter. This tube was suspended horizontally by a thread of silk. A minute magnet was affixed for controlling purposes, and a small mirror was used to indicate the deflections. The entire system was suspended in a little glass box, and is indicated in Fig. 2. When it is submited to the influence of the vibrations, the tube deviates and tends to set itself in the mean direction of the electrical force. To obtain greater deflections, I brought the two wires near together in the neighborhood of the apparatus, and reinforced their effect near the extremities of the body tested by two small plates, as Fig. 2 indicates, for a special case. Under these circumstances it was possible to obtain initial swings of over 100 scale divisions.

The results obtained differed by only a few per cent. As examples of the possibility of applying these deflections to purposes of measurement, I indicate two series of observations. The first shows the action of resonance. The apparatus was placed at *c*, the antinode of the vibration, and the wires *a b* and *a' b'* were brought near one another, as indicated in Fig. 2. The bridge piece *a a'* was then placed at different distances *e*, measured from B B', the induction coil was set working, and the value of *i*, the first swing was observed. The corresponding values of *e* and *i* in the neighborhood of the maximum were as follows :—

e	8,	90,	100,	110,	120,	130,	140,	150,	160 cms.
c	5.3,	10.0,	21.8,	51.2,	44.1,	19.3,	10.3	5.7,	4.2 div'ns.

The curve plotted from these values is very regular, and shows a maximum between 110 and 120 cm. The impulsive swing reached a maximum value, $i = 60.6$ divisions, for $e = 114$ cm.

The second series of tests was made with the view of showing the diminution in the intensity of the vibrations from the antinode *c* to the node *b*. For this purpose, the distance between them was divided into 12 equal parts, and the apparatus was successively placed at the 13 points of division so obtained. The following observations were made :—

No. =	1	2	3	4	5	6	7
i =	80.5 ...	80.5 ...	79.0 ...	77.0 ..	65.0 ..	57.8 ..	50.0
No. =	8	9	10	11	12	13	
i =	38.5 ...	27.5 ...	17.5 ..	7.0 ..	1.0 ..	0	

These values vary in a sufficiently regular manner for the purpose of judging the form of the vibration, and for making it evident that it differs in a very noteworthy way from a simple sinusoidal oscillation.

The result of other experiments on the direction of the electrical force in the neighborhood of the wires show that the extremities of the little tube seem always to be attracted toward the nearest portion of the wires.

For the study of the magnetic force, a ring 65 millimetres in diameter was used. This was suspended, as shown in Fig. 3, so that it could turn on one of its diameters, and furnished with a magnetic needle, a mirror, and a glass cage. Contrary to what might be expected, the ring does not remain at rest under the influence of the oscillations, but is acted upon by forces of the same order of magnitude as those evidenced by the action of the cylinder when placed at the antinode of the vibrations. Moreover, the direction of the deflection shows that the force between neighoring parts of the ring and cylinder is not an attraction, but a repulsion.

The repulsion is due to the oscillations, and its magnitude must depend on resonance, according to the same law as the electrical actions. The ring always sets itself perpendicular to the plane of the wire, whatever its position with reference to it, provided it lies within the contour *b b'*. We can deduce, therefore, from these experiments alone that, in addition to the electrical vibration, there exists a vibration of another kind whose nodes coincide with the antinodes of the former, and that the directions of the two classes of vibration are perpendicular to each other. Referring to the experiments, we can easily recognize the new vibration as magnetic. The rapidly oscillating magnetic force must, by induction, produce a synchronous alternate current in the closed metallic ring, and the reaction of this current produces a deflection. The magnetic force is a maximum at the nodes of the electric vibration, and at these points its direction is normal to the plane of the wire. That the action between neighboring portions of the ring and wire is a repulsion is easy to account for. The current induced in the ring is such as to neutralize within the ring the effect of the inducing current in the wire. The two currents accordingly flow in opposite directions and repel each other.

If the ring be moved away from the node *b* toward the antinode of vibration, the repulsion diminishes to zero, and then becomes an attraction, increasing until the antinode is reached. In a particular case the repulsion deflection at *b b'* was 20 divisions; it disappeared altogether at about 95 centimetres distance from the ends, and became an attraction, the maximum value of

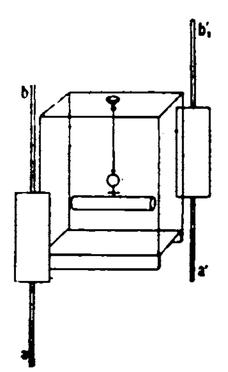


FIG. 2.

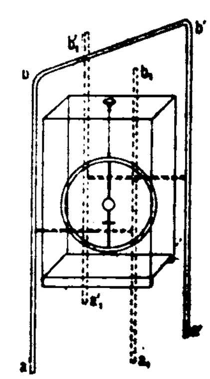


FIG. 3.

which was measured by 44 divisions. In order to explain these results it is necessary to consider the simultaneous action of the electric and magnetic forces, the former being greatest at *c*, and the latter at *b b'*. We can verify this explanation by investigating the variation of the magnetic force after having eliminated the action of the electric forces. With this view, place parallel to the wires *a b*, *a' b'*, two other wires of about 20 centimetres length, arranging the four wires symmetrically with regard to the equilibrium position of the ring as indicated by the dotted lines in Fig. 3. Also join *a b* to a_1 b_1 and *a' b'* to a_1' b_1'. In this way the electric action is evidently almost annulled, while the magnetic action is very little altered. We now observe a repulsion of the movable ring for all distances, diminishing to a minimum at the antinode of the electric vibrations. The minimum value is found to be four divisions. If the electric vibration was sinusoidal, the magnetic force would have disappeared at the node. The distribution of the electric force has already shown us that

1. Abstract of a translation from *La Lumière Electrique*, March 28, 1891.

this hypothesis is not exactly correct, and we can thus understand the existence of magnetic force even at the antinode. The mechanical actions of the electric and magnetic forces, as theory indicates, are in general of the same order of magnitude. The predominance of one or the other depends essentially on the mutual actions of the nearest parts of the ring and the solid conductor. The more nearly these are like infinitely short wires, the greater is the relative importance of the magnetic force; while the greater the surface of the conductors, the more the electric force predominates. From the above experiments on conductors of very simple form, it is evident that a conductor of any form, when placed in the path of a train of electromagnetic waves, is subjected to forces of a very complex character.

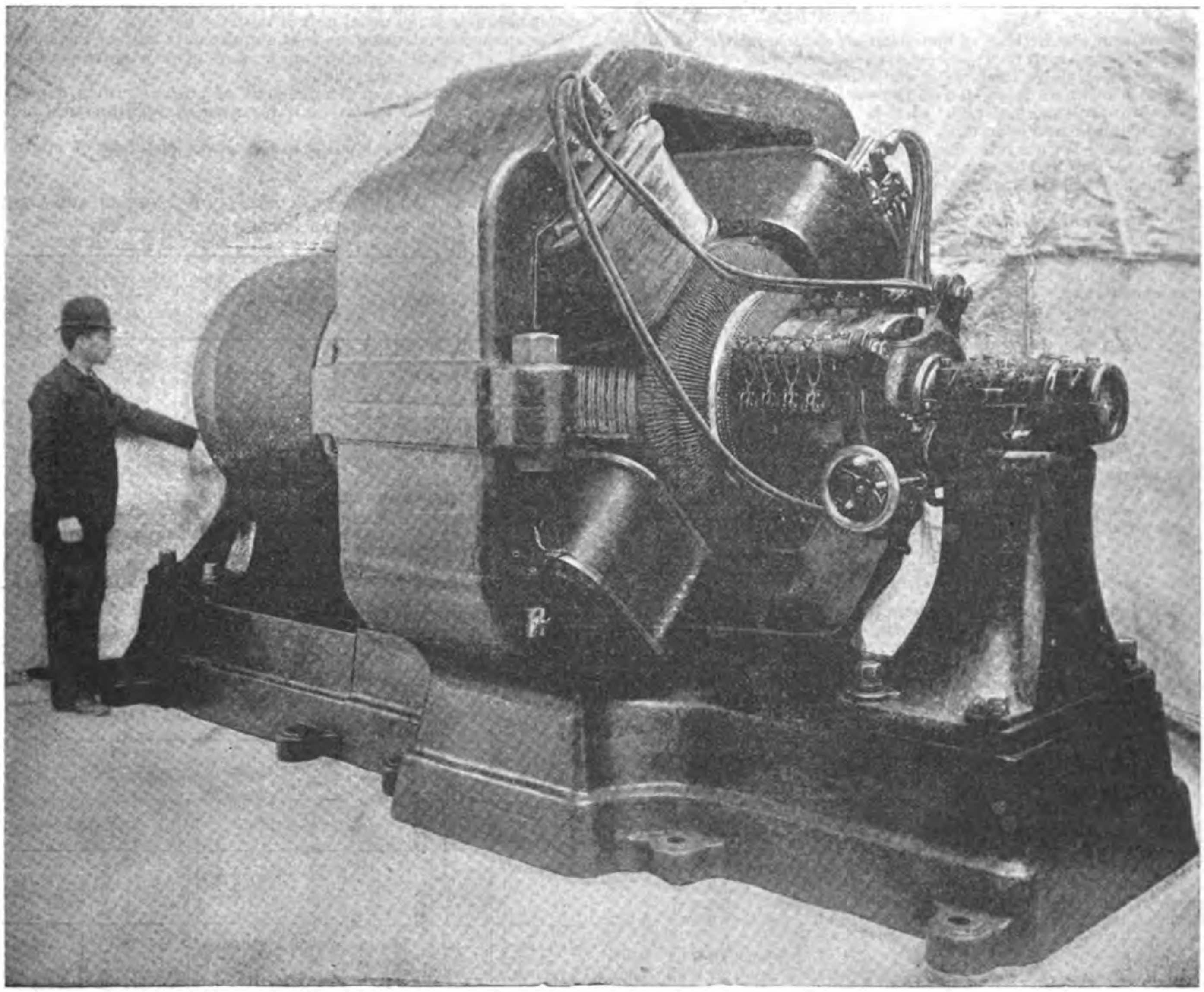
THE THOMSON-HOUSTON 250 H. P. GENERATOR.

The erection of power stations of large capacity for operating electric street railways in our large cities has created a demand for generators of greater output than have been heretofore employed. The first type of railway generator brought out by the Thomson-Houston Electric Company was a two-pole machine of the motor type pattern, having an output of 62,000 watts, which was followed by a four-pole machine of 75,000 watts capacity, which in turn has been followed by a generator of the same type, having an output of 250,000 watts.

The general construction of this machine will be readily seen from the accompanying illustration. The armature is of the Gramme ring pattern and so constructed that opportunity is afforded for the best insulation and the danger due to great difference of potential between any two of its conductors is avoided. This is a most valuable and important feature, as in case of accident or injury to any coil, it can be easily repaired without affecting in any way the remaining coils. The construction of the armature affords excellent ventilation, which is very necessary in dynamo machines, particularly as their size is increased, for the reason that the radiating surface does not increase in proportion to the size of the mass.

One of the most important features of this generator is the arrangement for lubrication and good alignment of the bearings. The boxes are made in two parts and are entirely separate from the stands. On the top of the stand is a seat into which the spherical surface of the box fits and in which the box is free to move. The bolts which secure it to the stand are smaller than the holes which are drilled through the box, so that a slight play of the box in the seat is permitted. The bearing shells or linings are removable, and are made in the following manner: A skeleton shell of brass is made, the interstices of which are filled with Magnolia metal. This is then bored and reamed to size, oilways being cut so that the oil circulation begins at the point where the oil rings touch the shaft. This method of manufacture permits of a perfect circulation of oil, ensures the cool running of the bearings, and greatly reduces the care and attention required by the dynamo when in operation. This type of box and bearing lining has proved so satisfactory that it is now being introduced in machines of smaller size, and will in future be used on all machines of large capacity. Whenever it is necessary to examine bearing linings, the armature is jacked up about one-sixteenth of an inch, so that the bearing is relieved of the weight, two bolts removed from each stand, and the entire box taken out. In case it is not desired to remove the box, the cap can be taken off and the bearing linings readily removed.

The movement of the brushes is effected by means of the shaft on which a small worm is attached, and which in turn works in a rack fastened to the yoke. By means of this a very fine adjust-



New Thomson-Houston 250 H. P. Multipolar Generator.

ment of the brushes can be made. The worm locks the yoke so that it cannot be moved except by hand.

In order that the conductors inside the armature may be held securely in place, an adjustable internal wire support has been designed. When the armature is being wound the wires are forced into position so that they cannot sag, vibrate, or chafe the insulation. All tendency to short-circuiting is thereby avoided and the position of the wires assured.

The commutator has 180 sections. In practice, the generator will have its fields separately excited, although the connection at the switchboard is so arranged that by throwing a switch the dynamo can be made self-exciting, should emergency require it.

The total floor space occupied by the 250 h. p. generator is 13 ft. 3½ in. x 7 ft. 1 in. The height of the machine is a little less than 8 ft. The pulley is 48 in. in diameter and has a 35 in. face. The speed is 400 revolutions per minute and the dynamo, complete, weighs about 21 tons.

FIELD'S DATA ON ELECTRIC RAILWAY WORK.

WHILE the method of operation of electric railways and the advantages which they possess over other forms of traction are now getting to be fairly well understood, there are still a large number of those interested in the subject to whom a handy résumé of the principal data, such as the power required, cost of construction and operation, etc., of electric railways would be welcome. With a full recognition of this desideratum evidently in mind, the Field Engineering Co., of this city, have recently published an excellent little folder, from which we take the following data:

The cost of an electric car equipment, including two motors, truck and car body complete, is from $3,200 to $3,500. There should be installed in generating capacity for power plant twenty to twenty-five horse power per car operated, which will give reserve power. The cost of generating power is from three to five cents per car mile. A car uses under average conditions one h. p. per car mile per hour. That is, a car operating at a speed of five miles, five h. p., at eight miles, eight h. p.

Cars are generally equipped with two fifteen h. p. motors. The tendency at present time is to slower speed motors, thereby reducing amount of gearing. The attainable speed with electric motors is limited only by condition of road-bed and local requirements; 130 miles an hour has been attained experimentally. Electric traction means rapid transit and increase of traffic of from 40 to 200 per cent. and moderate reduction in operating expenses per car mile.

One mile of single-track construction will cost complete with sixty-five pound girder rail, ties two and one-half feet on centres, bonding of rails, paving, etc., $9,000 to $10,000. The cost of the electric part of power plant, including generators, switchboard, etc., installed, is $35 to $45 per h. p.

Line construction per mile, complete, including track bonding, plain pole work, cross-suspension or bracket with feed wire................	$2,000 to $2,500
Sawed and painted poles,......................	2,500 to 3,000
Iron poles, concrete setting, cross suspension, double track, feed and guard wires............	6,500 to 7,500
Same with centre poles.........................	4,500 to 5,500

An electric car averages 100 to 125 miles a day.

The accompanying table gives the

COST OF ELECTRIC EQUIPMENTS FOR STREET RAILROADS.

No. of cars.	Steam plant. H. P.	Capacity of generators. K. W.	Steam plant.	Station electrical equipment.	Car equipments, bodies, trucks and motors.	Line construction ½ mile of double track per car.	Total equipment (omitting track).
6	120	80	$7,000	$6,400	$19,500	$15,000	$47,900
10	225	150	11,000	10,500	32,500	25,000	79,000
15	375	240	17,500	15,000	48,750	37,500	118,750
20	450	300	22,000	17,500	65,000	60,000	164,500
30	675	450	28,000	22,000	97,500	90,000	237,500
50	1,125	750	50,000	33,000	162,500	187,500	483,000
100	2,025	1,350	90,000	60,000	325,000	375,000	850,000

The above figures are approximate only and based on the best city railroad practice.

The cost of steam plant complete is for high speed $45 to $55 per h. p., and for Corliss, $65 to $75 per h. p. The number of units of power in power plant should be as few as is consistent with safety and economy of operation, but not less than two.

Engines operate at a piston speed of 600 to 800 feet per minute, high speed, so called, having in general the lower piston speed and shorter stroke and higher rotative speed or number of revolutions, and the Corliss the reverse. Corliss engines generally operate at 75 to 100 revolutions, and larger high speed, 150 to 225 revolutions. Belt generators direct to engines with Corliss and high speed, thus making each unit independent of all others; one generator to each engine is preferable.

Avoid use of counter-shafting by the above methods, and make belt centres as long as practical; 20 to 30 feet for high speed, and 40 to 50 feet with Corliss.

Engines on railway work should be built very heavy, and have ample fly-wheel capacity to relieve the working parts of the excessive strains due to changes in load.

Compound engines should not be run non-condensing on railway work; the loads are too variable.

Every effort should be made in locating power plant to obtain facilities for condensing, and operate plant wth compound condensing engines.

Ten to thirteen sq. ft. of heating surface evaporating 30 lbs. of water per hour is the usual unit of h. p. for boilers.

Compound condensing engines require only half of the boiler capacity of single cylinder ones, and give a corresponding economy in coal consumption.

On the designing and arrangement of power stations depend the economy of operation both for present requirements and future developments.

The best practice is tending to the direct coupling of engine and generator.

THE RELATIVE COMMERCIAL ECONOMY OF ENGINES AND COST ARE AS FOLLOWS:

Type.	Lbs. of coal per h. p. hour.	Cost per h. p. sizes over 100 h. p.	This is based on an evaporation of 9 lbs. of water per lb. of coal.
High speed single	4 to 5	$11 to $13	
" " compound	3 " 3½	14 " 16	
" " " condensing	2¼ " 2½		
" " triple	1¾ " 2	18 " 22	
Corliss single	3½ " 4	16 " 18	
" compound condensing	1⅔ " 2	22 " 25	
" triple	1½ " 1⅔	27 " 30	

THERE ARE THREE CLASSES OF BOILERS:

1. Horizontal return tubular, which is the most general in use, and costs $9 to $10 per h. p.

2. Vertical tubular (Corliss or Manning), which is a vertical tubular boiler with water leg, giving an internal fire-box, economical in floor space, largely used throughout New England. Cost, $10 to $12 per h. p.

3. Sectional or water tube boiler, of which Babcock & Wilcox is the best known, especially adapted for higher pressures and safety. Cost, $17 to $19 per h. p.

CAPACITY OF ENGINE REQUISITE FOR DIFFERENT GENERATORS.

Generators.	Engine.						
		High speed.			Corliss.		
Watts.	H. P.	Size.	Speed.	Wt. 2 fly wheels.	Size.	Speed.	Wt. 2 fly wheels.
50,000	75	12 x 12	280	7,000 lbs.			
80,000	125	15 x 16	225	9,000 "			
150,000	225	18½ x 18	200	15,000 "	20 x 36	90	25,000 lbs.
2-150,000	450				24 x 48	80	50,000 "

Steam pressure, 100 lbs.

All information here given represents the more advanced standard of construction, and the prices quoted are for the highest class of work and materials.

NEW FORMS OF INCANDESCENT LAMP.

As intimated in our columns last week, the Edison lamp decision is stimulating work on forms that will not infringe, and various rumors are current. It is stated from the West that a new lamp will very shortly be placed on the market which will not infringe on any of the incandescent lamp patents in force. Further particulars are promised at an early day, and their publication will be very eagerly awaited.

C. & C. DATA ON ELECTRIC POWER TRANSMISSION.

A most interesting and valuable pamphlet has just been issued by the C. & C. Electric Motor Co., devoted entirely to the discussion of questions connected with the transmission of power electrically for stationary motor work. One portion of it is practically a reprint of Mr. Lufkin's admirable paper read before the National Electric Light Association on "A Proper Basis for Determining Electric Motor Rates," and includes the tables or diagrams proving his argument as to the necessity of making rates on "maximum readings." Another very valuable section includes a series of forms of contract for motors and power current. A third section embraces the various rates charged for electric power. We have ourselves published a number of such rates before, but are glad of the opportunity to give these:

NEW YORK.

	INTERMITTENT WORK. Per month.	FREIGHT ELEVATORS. Per month.
⅛ h. p........	$3 00	......
¼ "	5 00	......
½ "	8 00	......
1 "	12 50	$10 00
2 "	22 50	15 00
3 "	30 00	18 33
4 "	36 66	21 66
5 "	43 75	25 00
6 "	50 00	28 33
7 "	56 88	31 66
8 "	63 33	35 00
9 "	69 37	38 33
10 "	75 00	41 66
15 "	100 00	60 00
20 "	125 00	......
25 "	145 83	......

Based on maximum readings.

Continuous work, 50 per cent. extra.

METER RATE.

10 cts. per h. p. per hour with discounts as follows:

	Horse power hours per month.	
On bills for	100 to 200	....20 per ct.
" "	200 to 400	.....25 "
" "	400 to 600	.....30 "
" "	600 to 800	.....35 "
" "	800 to 1,000	.....40 "
" "	1,000 to 1,500	.....45 "
" "	1,500 or over	.... 50 "

CHICAGO, ILL.

Applicable to classes of work in which the rate of power consumption is uniform, or nearly so, such as operating ventilating fans.

	Per month.		Per month.
¼ h. p. ...	$5 00	7 h. p.....	$65 45
½ "	8 50	8 "	78 20
1 "	14 00	9 "	81 45
2 "	25 00	10 "	90 00
5 "	50 75	15 "	135 00
6 "	57 90		

Applicable to classes of work in which the rate of power consumption is variable, such as operating machinery for printing, sewing, embossing, wood and metal working, pumping for hydraulic elevators, coffee grinding, baking, etc.

	Per month.		Per month.
⅛ h. p.....	$3 00	6 h. p.....	$42 60
¼ "	4 50	7 "	47 25
½ "	6 50	8 "	52 50
1 "	10 00	9 "	57 15
2 "	18 50	10 "	62 50
5 "	37 25	15 "	93 75

Based on maximum readings.

ELEVATOR WORK.

Applicable only to elevators driven by belts direct from the motor.

	Per month.		Per month.
4 h. p.....	$26 00	8 h. p.....	$42 00
5 "	30 00	9 "	46 00
6 "	34 00	10 "	50 00
7 "	38 00	15 "	70 00

In Philadelphia, the meter rate is 7½ cents per h.p. per hour for less than 1,500 h. p. hours per month. Over that it is 5 cents per h.p. hour. Boston charges 10 cents per h. p. per hour, with discounts ranging from 20 per cent. up to 40 per cent. The above are figures of plants run by steam. In Rochester and Des Moines, where the generators are driven by water-power, the rates are as follows:

ROCHESTER, N. Y.

¼ h. p.....	$18 00 to $30 00	per year
½ "	5 00	per month
1 "	7 00	"
2 "	10 00	"
5 "	25 00	"
10 "	36 00	"
15 "	50 00	"

DES MOINES, IOWA.

	CONSTANT. Per month.	INTERMITTENT. Per month.
¼ h. p........	$4 00	.... $3 00
½ "	5 00	.... 3 75
1 "	8 00	.... 6 00
2 "	14 00	.... 10 00
3 "	20 00	.... 14 00
4 "	25 00	.... 17 00
5 "	30 00	.... 20 00
7½ "	40 00	.... 28 00
10 "	50 00	.... 33 00
15 "	70 00	.... 46 00
20 "	90 00	.... 60 00
25 "	110 00	.... 72 00

ELEVATOR WORK

3 h. p................	$12 50
5 "	18 00
7½ "	25 00
10 "	30 05
15 "	40 00

A great many excellent points are made in the discussion of electric power. With regard to dynamos it is said:

In selecting a dynamo for a commercial power circuit a series or constant current machine should not for a moment be considered. The argument that it requires less copper for the circuits is a snare. A constant potential dynamo of 500 volts pressure (or less where limited areas are to be covered) is the only dynamo which should be considered, and the size should be as large as the prospective supply of power will warrant. There are, however, conditions found in special transmissions of power where a potential of 1,000 volts or even higher may to advantage be employed. Let us for a moment compare these different types of machine. To approximate the output of a 50-light constant current or series dynamo we will analyze the duty which it performs. One arc lamp (10 amperes, 45 volts) consumes 450 watts of energy, or a total energy of 22,500 watts consumed in the 50 lamps. In a circuit of 10 miles of No. 5 B. & S. wire there would be a resistance of about 17 ohms and a consequent loss in energy of 1,700 watts in the circuit carrying 10 amperes of current, which, added to the 22,500 watts consumed in the lamps, makes the total output of the dynamo 24,200 watts. To develop this energy of 24,200 watts (50 arc lights) the average series or constant current dynamo requires 50 h. p., indicated in the engine in the station.

With this same 50 h. p. indicated in the engine we will guarantee to deliver with one of our constant potential power dynamos from 30,000 to 35,000 watts at the dynamo terminals according to the loss in friction in the engine. In other words, approximately 25 per cent. greater output of electrical energy for the same indicated horse-power in the engine. This saving of 25 per cent. in engine and gross dynamo capacity will more than pay for the difference in cost of copper for the constant potential circuit, besides requiring 25 per cent. less fuel for the continuous operation of the plant. Again a potential of 500 volts is incapable of doing serious bodily harm, and for this reason, if for no other, should commend itself for almost universal use.

On the subject of rates, the disquisiton is very pithy: To establish an equitable power rate has been a somewhat difficult task, in the first place because of the unwillingness of both the company supplying the power as well as the user to rely on a meter measurement of the power consumed; and in the second place, the difficulty of correctly estimating the power which will be used in driving a given lot of machinery for ten hours each day, and on this estimate basing a contract rate. This condition of affairs first led to the adjustment of power rates solely on the basis of the possible or rated horse-power of the motor employed. While, in general, rates established on this basis are unsatisfactory and even unjust to the consumer, they are necessary in the case of motors on series or constant current circuits for the protection of the station, it being a fact that the fluctuations in power on the circuit show littl eeffect in the saving of the initial power in the station. Not so on a constant potential circuit, and the method of rating just described was soon discarded for what is generally known as a "Maximum Reading" rate, the customer being charged for power on the basis of the maximum reading shown on an ampere meter placed in series with the motor from time to time as the circumstances of the case required, or on the addition of any new machinery. In some of the contract forms is a clause giving authority for making this reading from time to time. From records obtained from all parts of the country and from many different classes of machinery being operated by electric motors, it has been determined beyond a chance of error that the general average use of an electric motor does not exceed 40 to 45 per cent. of its rated capacity, while the average maximum load carried by the motor as shown by these same records does not exceed 65 to 70 per cent. of its rated capacity. To make this possibly a little more clear: On a circuit to which is connected 100 h. p. in rated motor capacity, the electrical horse-power supplied to this circuit in the station will not exceed, as a maximum, 70 h. p., and the average power supplied will not exceed 45 h. p. On one circuit with which we are familiar this maximum of 70 per cent. was only reached once during a stated month and then but for a period of about five minutes. On several circuits the average station reading is as low as 25 to 30 per cent. of the gross motor capacity connected. Hence, it will be seen that a motor rate based on 70 per cent. of the indicated horse-power of any given motor of high efficiency to be supplied with current will obtain for the station a high rate for the power. The conditions here outlined cannot be obtained with cheap and inefficient motors. In a recent case a 25 h. p. motor of our make was installed in place of a 15 h. p. of another make, the duty required of the motor being increased about 25 per cent. over that required of the 15 h. p. machine, the station supplying the power increasing their charge per month in proportion. The records on this motor show that the current supplied at present is no more than was supplied to the 15 h. p. machine, while the station is receiving a 25 per cent. increased revenue. In establishing a contract rate for electric power this matter of efficiency and and reliability of the motor will be found an all-important factor.

An electrical horse-power in the station should not cost to exceed 1¼ cents per horse-power per hour, or at the rate of $45 per year per horse-power with coal at $3.50 to $4.00 per ton. On this basis of cost in the station and adding 10 per cent for loss in the circuit and 10 per cent. for loss in the motor, it makes the cost of an actual horse-power delivered to the user $54.45 per year, or $4.54 per month. Taking the rates of the Brooklyn Edison Co. on a 10 h. p. motor, published in this pamphlet as an illustration, they being the cheapest rates we know of where steam power is used, we will illustrate the method of charging before referred to, and the profit to be derived at the Brooklyn rate for power. The cost of coal in Brooklyn averages about $8 per ton:

Motor in use, 10 h. p.
Maximum reading on motor, 70 per cent., 7 h. p.
Average power delivered by motor, 45 per cent., 4½ h. p.
Rate for 7 h. p. per year.......................... $470 00
Cost of 1 h. p. delivered per year.................. 54 45
Cost of 4½ h. p. delivered per yer.................. 245 02
Profit.. 224 98

ELECTRIC LIGHTING BY MUNICIPAL AUTHORITIES.[1]

BY PROF. HENRY ROBINSON, M. I. C. E., M. I. E. E.

A REVIEW of the subject of public lighting, which concerns municipal authorities very closely, shows that for the lighting of streets arc lamps are the most economical. The smallest made require five amperes of current, but it is not desirable to use less than six. The candle power varies with the angle at which it is measured, 40° below the horizontal line being a maximum for constant current lamps. The following table gives the approximate candle-power at various angles. The height of the lamps should be arranged so as to give an angle of not less than 7° to the most distant point which it is intended to serve:

LIGHTING POWER OF ARC LAMPS.

Current in amperes.	Horizontal.	At angle of 7°.	At angle of 10°.	At angle of 20°.	Maximum at angle of 40°.
	c. p.	*c. p.*	*c. p.*	*c. p.*	*c. p.*
6	92	175	207	322	460
8	156	300	350	546	780
10	220	420	495	770	1,100

The following table gives the cost of working arc lamps:

Current in amperes.	Average candle power at angle of 20°.	Watts required.	Units used per hour.	Cost of current at 3½d. per unit.	Cost of carbons .50 and fixing .16.	Total cost per lamp hour.	Cost per average candle-power per hour.
				Pence.	*Pence.*	*Pence.*	*Pence.*
6	322	300	0.3	1.05	0.66	1.71	·00531
8	546	400	0.4	1.40	0.66	2.06	·00377
10	770	500	0.5	1.75	0.66	4.21	·00313

The last column in the table gives the cost per candle-power per hour, and these figures are arrived at by dividing the "total cost per lamp hour" by the figures representing candle-powers "at an angle of 20°" (given in the table of lighting power), which represents a fair average of the power from arc lamps.

Arc lights should be placed high up on account of their high candle-power and great distance apart, because the light thrown down at an angle is much greater than that cast horizontally, and because the light given horizontally is not so steady as that which is thrown down at an angle.

The following data enable the coefficient of minimum lighting power in streets to be determined:

Let P=candle-power of lamps.
L=maximum distance from lamp in feet.
H=height of lamp in feet.
X=a coefficient.

The light falling on a unit area of pavement varies inversely as the square of the distance from the lamp, and is directly proportional to the angle at which it falls. This angle is nearly proportional to the height of the lamp divided by the distance. Therefore,

$$X = \frac{P}{L^2} \times \frac{H}{L} \quad \text{or} \quad X = \frac{PH}{L^3}.$$

The usual standard of gas lighting is represented by the amount of light falling on a unit area of pavement 50 ft. away from a 12-c. p. gas lamp 9 ft. high, which gives a coefficient as follows:

$$X = 12 \times 9 \div 50^3 = \cdot 000864.$$

Adopting the above coefficient, I calculate that the before-mentioned sizes of arc lights will give the same standard of light at the heights and distances stated in table A.

1. Abstract of a paper read before the London Meeting of the Association of Municipal and County Engineers.

TABLE A.

Current in amperes.	Height of lamps.			
	20 ft.	25 ft.	30 ft.	35 ft.
	Maximum distances served from lamp in feet.			
6	160	175	190	203
8	185	202	220	235
10	205	225	243	260

Table B gives the corresponding distances, assuming the minimum standard to be doubled, thus bringing the coefficient up to .001728, which represents the amount of light on a unit area 50 ft. away from a 24-c. p. lamp 9 ft. high:

TABLE B.

Current in amperes.	Height of lamps.			
	20 ft.	25 ft.	30 ft.	35 ft.
6	130	144	155	166
8	150	165	180	193
10	170	190	205	220

The distances apart of the lamps would, of course, be double the distances mentioned in tables A and B.

One arc lamp will take the place of from three to six gas lamps, according to the locality, arrangement, and standard of light adopted. A scheme of arc lighting, based on the substitution of one arc light on the average for 3½ to 4 gas lamps, would double the minimum standard of light, whilst the average standard would be increased 10 or 12 times.

ELECTRICITY vs. THE HORSE, IN BOSTON.

The following statistics concerning the comparative operation of the West End Street Railway as respects horses and electricity in the months of April and May have been given out. The West End, it is to be borne in mind, is as yet imperfectly equipped electrically, buying its power where it has not had time to complete its own plant, and has labored under the many organization disadvantages arising from so great a change as from horse to electricity:

APRIL STATEMENT.

	Electric.	Horse.
Gross receipts	$134,321	$344,896
Net earnings	48,487	67,449
Per cent. operating expenses	63.86	80.62
Earnings per mile run	34.05c.	31.77c.
Net earned per mile run	12.30c.	06.22c.

MAY STATEMENT.

	Electric.	Horse.
Gross receipts	$144,638	$374,605
Total operating expenses	84,163	269,556
Net earnings	60.475	105,049
Per cent. operating expenses	58.18	71.95
Earnings per mile run	38.43c.	34.22c.
Net earned per mile run	16.07c.	09.60c.

The long electric cars make an even better showing than the above. They are operated by the same sized Thomson-Houston motors as the smaller cars, and by reason of increased capacity earn considerable more per mile. The company is operating seventy-five of these cars now, has seventy-five more in the shops awaiting adjustment of trucks, and will eventually have many more in operation. These long cars earned $83,000, or forty-four cents per mile operated, in May, and forty-six and nine-tenths cents per mile operated in the first half of June, the latest obtainable figures.

When the West End has finished its own power houses it is calculated that it can reduce expenses of operating its electric cars to at least twenty cents per car mile, and with the long cars, earning above forty cents per car mile, it can considerably extend the long car service and still operate them upon a basis of fifty per cent. for expenses.

The West End service covers about 18,000,000 car miles run per annum, and it is not difficult from this fact and the data above given to figure that the change from horse to electricity is more than worth the expenditure upon capital account.

The net earnings of the West End gained over the previous year $15,000 in May, and though the figures are not yet made up, it will probably show a gain of $30,000 net for June. The net earnings of June and July should be about $200,000 for each month.

KAPP, RECKENZAUN AND JARMAN AT THE ENGLISH TRAMWAY INSTITUTE.

THE Tramway Institute at their annual meeting gave a fair opportunity to the discussion of electric traction and I think, writes our London correspondent, it may have some good results. The Institute is fortunate in possessing a president who is well acquainted with traction work in America; therefore he could bring experience to bear upon any discussion which might arise. Electric traction was represented by such men as Kapp, Reckenzaun, Holroyd Smith, Gordon, Jarman. Mr. Kapp presented a paper on the Lineff system. It was a little fuller than the paper read at the British Association last year. The lecturer referred to the conditions of closed conduit and compared it with the slotted rails at Buda-Pesth, where there is an underground conductor. The author maintained that such an underground open conduit system is rather expensive and was objected to by the general public and by tramway men. Lineff's system, therefore, in his opinion, offered advantages, both in cost and convenience, over the older rival. Overhead conductors would not be started in England, and storage-battery cars were too heavy, as the power necessary to propel the vehicles was in the proportion of 11.5 to 6.5, the larger figure represented the energy requisite for the battery car over a car deriving its current from a metallic conductor. This not only affected the coal bill, but also the depreciation and interest upon the larger plant required. The estimated cost of Lineff conduit was about £2.500 per mile of double track. It contained two conductors, the current being returned by the tram rails and the earth. Regarding the efficiency of the system, it was ascertained that 14 per cent. of the power is lost through exciting the large magnet which actuates the movable conductor; another 4 per cent. is wasted in propelling the said magnet over the line, and the other loss estimated at 1 per cent. is due to leakage on the straight surface. All other loss, such as that due to resistance, is the same as any other system requiring conductors. The insulation resistance in the channel had been materially improved. In the original line it was 4475 ohms per mile, and that was obtained when the entire surface of the conductor was resting upon the bottom of the channel. The present improvement consists in supporting the metal strip upon divided insulators, whereby the surface of contact is enormously diminished, with the result that this resistance has been increased to 85,000 ohms per mile. Further improvements might be effected by blowing air from the channel, and thus effectually carrying off any accumulated moisture.

Mr. J. Sturgeon contended that the line on which the results had been obtained was too short for any definite information to be given of the system. Mr. Reckenzaun, in rising, said he was bound to take exception to several of Mr. Kapp's statements with regard to the insulation measurements of Mr. Lineff. It appeared to him somewhat premature considering that the tests were made on an experimental track some 70 yards long, and in the condition of laboratory experiment. The possibility of leakage increases with the length of the line, especially in those cases where sections of conducting rails are periodically in actual contact with the roadway, which after a soaking rain must be a good conductor. Moreover, the minute cracks in the conduit, which are likely to result from abnormally heavy traffic will readily establish sources of leakage between the inner conductor and earth. Concerning the channel, Mr. Kapp had referred to the objection against slotted conduits, and he had also mentioned the Buda-Pesth tramway. The Buda-Pesth conduit was immediately underneath one of the rails, which must have slots for the wheel flanges to run in. There is therefore no additional opening in the road. What tramway men wanted nowadays were figures relating to the working cost of propelling cars by electricity, and he, Mr. Reckenzaun, had brought information from two important Continental lines. The total length of the electric tram-line of Buda-Pesth is 16 kilometers. It has been in operation for about 18 months. The popularity of the electric system is shown by the large number of passengers carried. The number per kilometer was 2,690. These increased in December of the same year to 3,631. The horse tramways of the same place, however, carried 2,730 and 2,267 passengers during the corresponding months, showing a material falling off. The maximum speed allowed by the municipality is 11 miles per hour. The expenses of the electric tram amounted to 45.4 per cent. of the gross revenues, whilst with the horse tramway of the same city the ratio between expenditure and income was 71.8 per cent., which corresponded with the best English tramways. Referring to the cost of construction and equipment of Austrian lines, it was shown that the horse tramways of Vienna have cost £4,100 per mile, steam tramways of the same city, £7,000, and the electric tramways of Buda-Pesth, £3,000 per mile, of which £1,400 was expended on the conduits and conductors. Electric traction expenses, inclusive of all charges, were, during the year 1890, 2s. 8d. per car kilometer. The other line which was in his mind was that of Frankfort, which has been in operation for about 7 years. In this case also comparisons can be made between horse traction and electric traction. The Frankfort tramway is worked with overhead conductors. It was built by the same firm as in Buda-Pesth, Messrs. Siemens & Halske. Last year the electric cars made 519,770 car kilometers at a cost of 2.73 pence per kilometer, whereas the traction expenses on the horse-car lines of Frankfort were 5.04 pence per car kilometer, showing a saving of 46 per cent.; but in the case of the electric tram-lines two cars were always coupled together, carrying only one driver and a conductor, consequently the comparison is not quite fair. On the other hand, the horse tramway has a very much greater traffic. It can easily be shown that if the electric tramway were worked on the same scale as the horse tramway and the car had its own motive power and attendants the saving would amount to at least 40 per cent.

In conclusion, the speaker said he wished to point out another error in Mr. Kapp's paper, and that related to the per cent. between the power required to propel a storage battery car and an electric car actuated with an overhead or underground conductor. It had been repeatedly found in practice that the energy necessary at the central station is practically the same for all cases under similar conditions. It is perfectly true that the storage car has from 1½ to 2 tons more weight to carry, and that the working efficiency of the cells is not much more than 70 per cent. But the plant at the central station, with conductor systems, must be large enough to respond at any moment to the greatest demand for current, and this is often three to four times as much as the average working rate. The fluctuations in power were enormous; within the space of a few seconds it may vary between zero and the utmost energy the engine may be capable of exciting. This is a serious disadvantage with the conductor systems, and entails waste which is infinitely greater than that usually accounted for as "loss on the line," etc. Storage batteries are, on the other hand, charged with a constant current, the engine and dynamo run all day at their best efficiency with a steady load, and the fluctuations occur only in the car, when the cells give out the energy demanded by the exigencies of road and load. The losses due to conversion of energy in the batteries and the extra weight are fully compensated by the steady working at a uniform rate of the charging plant.

A paper was then read on the Jarman system by the inventor. Experiments had been carried on since the year 1886 with storage-battery cars at Clapham, and the author had been working hard in perfecting the system. Since the description of the car which appeared last year important modifications have been made. One was in the car; the spur wheels were provided with fibre teeth which were durable and could be replaced easily and worked silently. The motor now used makes only 650 revolutions per minute when these cars run at the rate of 8 miles per hour. The brushes consist of 5 square carbon pencils abutting against the outer edge, the pencil carrying its own current through flexible connections. These brushes worked very satisfactorily. Mr. Jarman found that the accumulators which were originally set did not fulfill the requirements of electric traction, and he constructed a new kind of cell, which promises increased durability.

NEW YORK NOTES.

MESSRS. MILLIKEN BROS., of New York and Chicago, report business rushing. In the line of iron-roof work, of which this firm make a specialty, they have lately secured contracts for Allentown for the new electric line; for a large boiler house at New Orleans, La., and for the Newark, N. J., power house. After a sharp competition with their competitors they have secured contracts for their patent poles for the new electric line in New York City and at Providence, R. I. Both these contracts are large and desirable, and the fact that they secured them speaks well for the many advantages of their poles. At the suggestion of Mr. McIntire this firm has introduced a new form of eye bolt in tops of poles, which contains an additional insulator. It is made in the form of a fork, having a special porcelain insulator in the end. Parties interested in these matters should correspond with the above firm.

FAIRPORT, N. Y.—The proposed electric road to Fairport, as laid out by engineer John Skinner, shows light grades and easy curves, that reflect great credit on his skill, when the difficult nature of the ground is considered. It is not decided whether operations on this line will be begun this season or not.

MR. E. R. KNOWLES, C. E., who has long been actively connected with electrical work, has just been appointed chief electrician to the Schuyler Electric Co., with headquarters at Middletown, Conn., where the factory is situated. He will assume his new duties on August 1.

L. J. WING CO., of this city, so well known for their fan and ventilating apparatus, etc., are pushing their Regan gas or gasoline vapor engines, which are already familiar to the trade and in growing demand.

MR. JOHN MAC CORMACK, M. E., formerly connected with Van Zile, Mac Cormack & Co., of Albany, N. Y., has connected himself with the Heine Safety Boiler Co., of 45 Broadway, N. Y.

MR. P. CLAUS is the New York representative of the Germania Electric Co., manufacturers of the Schaefer incandescent lamp. His office is at 63 Broadway.

Society and Club Notes.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

The Montreal *Star* of July 15 has the following: There was a meeting last evening at the Windsor Hotel of the executive committee of the General Citizens' Committee, formed in connection with the approaching convention of the National Electric Light Association of America. Prof. Bovey presided, and there were also present Prof. McLeod, Prof. Cox, John Kennedy, J. Fairman, J. A. U. Baudry, L. B McFarlen, J. Carroll, J. S. Shearer, S. C. Stevenson, and A. J. Corriveau. Prof. Bovey stated that the finance committee of the City Council had increased their recommendation for an appropriation from $1,000 to $2,000. A resolution was also passed thanking the Mayor, City Council and the finance committee for their generous appropriation. The formation of the reception committee was then discussed, and a number of names added to the executive committee. The remaining time of the meeting was devoted to a consideration of the entertainments to be given the visiting electricians. The conversazione at McGill College had been decided upon, and Prof. McLeod and Mr. Carroll were appointed to look after it. Should they give a ball or a banquet, or either? Mr. Fairman thought an estimate of the cost should be made before deciding, so as not to go beyond their means. This was agreed to. Prof. Bovey reported progress in regard to arranging garden parties and receptions. They could secure as many as they wished. It was suggested that a lacrosse match be arranged. Mr. Kennedy was requested to secure invitations from the Grand Trunk and Canadian Pacific Railway Companies for the members of the convention to visit their works. Mr. Fairman was to secure a similar invitation from the Dominion Bridge Company, and Mr. Stevenson was to report on a visit to the Forest and Stream Club's quarters. Other entertainments were discussed.

CHICAGO ELECTRICAL ASSOCIATION.

After a highly interesting meeting on July 14th, the Chicago Electrical Association adjourned until September 8th, when the regular fortnightly meetings will be resumed in St. George's Hall, 169 Washington street. This young society held its first gathering last April, when a number of young electrical workers decided to organize it. The score of members are taking active hold and the half a dozen meetings already held promise well for the future of the association. Having neither a lunch-room nor a life insurance connected with it, the Chicago Electrical Association stands apart from both the Electric Club and the Electrical Mechanics. Its chief aim is to bring the members together to listen to papers on various subjects and to discuss them. Half a dozen prominent houses are represented, and the discussions are both lively and thorough. The officers for the present year are as follows: President, J. F. Connor, of *Electricity;* Vice-President, F. R. McBerty, Western Electric Co.; Secretary, E. G. Hovey, Western Electric Co.; Treasurer, D. E. Webster, Electrical Supply Co.

College Notes.

McGILL UNIVERSITY, MONTREAL, CAN.

Prof. Bovey has been informed that the McGill University is to be the fortunate recipient of a very valuable electric light plant, consisting of dynamo and arc lamps. The plant is of the celebrated "Wood" system, manufactured and presented by the Fort Wayne Electric Co. Mr. W. J. Morrison, their general agent, together with Mr. A. J. Corriveau, president of the Canadian Electrical Construction Manufacturing Supply Co., representing them in Montreal, have been instrumental in securing this generous gift.

PURDUE UNIVERSITY.

During the vacation many changes are being made in the mechanical and electrical laboratories of Purdue University. The new mechanical laboratory building, together with the electrical building, will give Purdue the finest equipment in the West for practical instruction in electrical engineering. The new building is to contain a set of Westinghouse air-brakes and a Mogul locomotive, both of which will be used for experimental work. The collection of dynamos and motors is growing steadily, and a number of fine electrical measuring instruments have recently been added.

Reports of Companies.

ST. PAUL, MINN.—At the annual meeting of the St. Paul and Minneapolis Messenger and Telephone Co., the following directors were elected: F. D. Abbey, F. M. Schutte, and John A. Ebel. At a subsequent meeting of the directors the following officers were elected for the ensuing year: F. D. Abbey, president; John A. Ebel, vice-president and general manager; F. M. Schutte, secretary and treasurer. It was decided at the meeting to extend the lines of the company and make other needed improvements.

BANGOR, ME.—At the annual meeting of the Maine Telegraph Company the following officers were chosen for the ensuing year: Directors, A. W. Paine, C. E. Bliss, F. A. Wilson, A. C. Flint, John F. Colby, Arad Thompson, C. P. Stetson, Bangor; E. F. Littlefield, Winterport; George Bliss, Waldoboro; president, A. W. Paine; secretary and treasurer, J. Y. Ricker. A dividend of $2 per share was declared. A great many Maine people are interested in this company. It owns the important lines in Maine which are operated by the Western Union, the latter company leasing them.

Appointments, Etc.

MR. M. C. SULLIVAN, who for a year past has very successfully represented THE ELECTRICAL ENGINEER in New York, has resigned to become connected with a new and growing branch of electrical business. Mr. Sullivan's zeal, loyalty and perseverance are such as to make a mark anywhere, and his old associates can only wish for him the abundant prosperity which they know he will win for himself as an electrical engineer and business man.

MR. W. E. STOW, who for the past nine years has been connected with the electrical interests of New England, has been appointed the New York Agent for THE ELECTRICAL ENGINEER. Mr. Stow has been actively connected with the electrical industry since 1882, when he entered the employ of the New England Department of the Edison Electric Light Co. He will also be remembered by his New England friends as having thereafter been successively connected with the Thomson-Houston Electric Co., the Sprague Electric Motor Co., the Wright Electrical Engineering Co., and the Standard Electric Supply Co., of Boston.

Literature.

"ELECTRICITY."

There is no limit to the ambitions of Chicago, and it appears to be one of the resolves of the great metropolis of the West to have as many electrical journals as New York can boast of. We have received from that city a copy of the new paper *Electricity*, just issued there. It is in every way a commendable publication, tastefully got up, beautifully printed, well edited, and abundantly provided with that which is, after all, the journalistic staff of life—advertising. The paper has a distinct aim and that is to handle all electrical topics in a popular manner, yet so fully and accurately that the technical reader will also be satisfied. Clearly there is a mission for such a journal in this country, and *Electricity* bids fair to become a power if it lives up to its early promise. The names of the men connected with it are a guarantee of good and honest work. Mr. J. W. Dickerson is editor in Chicago, and Mr. George H. Guy in New York. Mr. W. S. Key is the manager of the Boston office, and Mr. C. McL. Paine of that in New York. The president of the company is Mr. W. H. Temple; the secretary and treasurer, Mr. H. S. Skilman, and the business manager, Mr. Irving Washington. *Electricity* will appear weekly, and at a subscription price of $2.50 per year offers full value. We can only wish every kind of prosperity to this latest electrical enterprise of the great and growing West.

THE STORAGE-BATTERY LAUNCH "MAGNET."

Mr. Fred. Reckenzaun, of West Hoboken, N. J., has recently sold his pioneer American storage-battery launch "Magnet" for use in California. It is to be placed by the purchasers, the Wieland Bros., brewers, of San Francisco, on Lake Tahoe. At the end of the season it will be removed to Sansalito, the headquarters of the San Francisco yacht clubs, to be run on the bay during the winter. The Pacific Electrical Storage Co., of San Francisco, has contracted to furnish a charging plant for Lake Tahoe.

Legal Notes.

THE KENNEDY PATENT ON ALTERNATE CURRENT DISTRIBUTION.

As a matter of general interest, we reprint below the patent of Rankin Kennedy, of Glasgow, Scotland, on which a suit has recently been brought by the Westinghouse Company against the Marble City Electric Light Co., of Rutland, Vt., the real defendant being understood to be the National Electric Manufacturing Co., of Eau Claire, Wis. Although the invention of Kennedy was made as early as 1883, having been fully described by him in the *Telegraphic Journal and Electrical Review* of June 9 and June 16 of that year, his application for the patent in this country was not made until November 13, 1888. This was early enough, however, it is said, to save his patent from the effect of the provision of the statute, that the invention must not have been two years in public use in this country prior to the date of application.

In the opinion of Judge Colt in the case of the Westinghouse against the Sun Company, in 1888, it was said :—

The most important improvement was made by Zipernowsky and Deri in their English patent of March, 1885. This patent describes minutely a system of distribution by induction through potential reducing converters combined in multiple arc, and it includes an alternating current dynamo generating a current of high potential.

Now as it was held, in the same opinion, that there was no invention in the reduction from high potential to low through a converter, it would seem, or is held, that while Kennedy had clearly not thought of this particular feature of a system of distribution, yet all that was essentially new in the apparatus of Zipernowsky and Deri, referred to by Judge Colt as the most important improvement which had been made in the art of alternating current distribution, was embraced in his discovery. The claim of the Kennedy patent, it will be observed, covers in the broadest terms the important principle of self-regulation, which is a direct consequence of his arrangement of the converters in multiple arc instead of in series, as had previously been the practice of Jablochkoff and Gaulard and Gibbs.

UNITED STATES PATENT OFFICE.

RANKIN KENNEDY, OF GLASGOW, COUNTY OF LANARK, SCOTLAND, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE WESTINGHOUSE ELECTRIC COMPANY, OF PITTSBURGH, PENNSYLVANIA.

SYSTEM OF ELECTRICAL DISTRIBUTION.

Specification forming part of Reissued Letters Patent No. 11,031, dated September 24, 1890. Original No. 407,291, dated July 16, 1889. Application for reissue filed August 28, 1889. Serial No. 322,251.

To all whom it may concern:

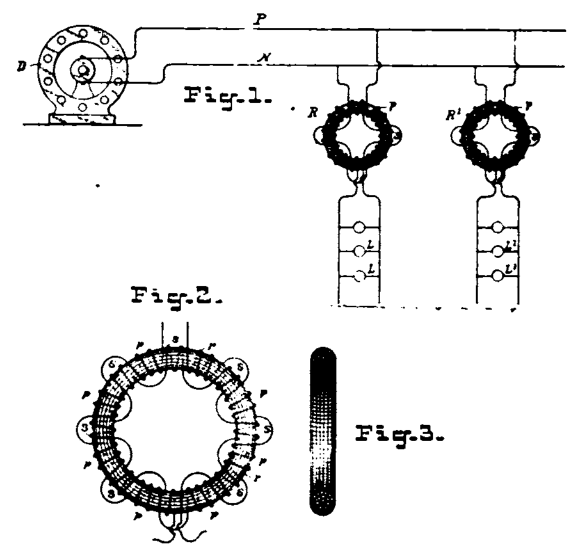
Be it known that I, RANKIN KENNEDY, a subject of the Queen of Great Britain, and a resident of Glasgow, county of Lanark, Scotland, have invented a new and useful Improvement in the Method of Distributing and Regulating Alternating Electric Currents by Secondary Generators (Case 232), of which the following is a specification.

In systems of distribution by alternating electric currents employing stationary induction-coils or secondary generators, it was customary, in the practical use of secondary generators prior to my invention, to connect all the primary coils in the circuit of the source of alternating currents in series. In such an organization the primary conductors of all the secondary generators are traversed in succession by one and the same current, and as a consequence any variation in the resistance opposed to the passage of the current through any one primary coil produced a corresponding variation in the current flowing through the primary coil of all the other secondary generators. It was found in practice that opening the secondary circuit of any of the secondary generators resulted in greatly diminishing the current delivered to all the others, and thus the entire system would be disturbed by turning off the lights at any one point. No entirely satisfactory method of overcoming this defect has been discovered. I have found that a counter electromotive force is set up in a coil of wire carrying an alternating current and wound upon an iron core, and this counter electromotive force is proportionate to the size of the iron core and the length of wire in the coil surrounding the core. I have also found that when the secondary circuit of a properly-constructed secondary generator is open or disconnected and an alternating electric current is applied to the primary coil, a counter electromotive force is developed in the primary coil which is practically equal to the applied electromotive force. When, however, secondary currents are allowed to develop in the secondary coil, the counter electromotive force is so modified that a primary current flows which varies approximately inversely as the resistance offered to the development of the secondary current. Availing myself of this discovery, I have devised a new method of distribution of energy by alternating electric currents, by which the secondary generators are rendered independent and self-governing, each receiving its appropriate current independently of all the others, and each deriving from the source an amount of energy proportionate to that which is actually consumed in the secondary circuit. In carrying this method into operation the primary coils of the secondary generators are connected with the source of energy in branch or derived circuits and the secondary coils are closed through the lights arranged in parallel arc. In such an organization each secondary generator receives its current independently of all the others, and the primary current in each secondary generator increases as the resistance in its secondary circuit decreases; or, in other words, the primary current increases as the current in the secondary circuit increases. From this it follows that the energy supplied to the primary coil or consumed by the secondary generator may be made nearly directly proportional to the work being done, and the whole system becomes self-regulating and flexible.

In the accompanying drawings, Fig. 1 is a diagram illustrating my improved organization of apparatus for electrical distribution, in which two secondary generators are shown connected with the source in parallel arc. Fig. 2 is a diagram illustrating the principle of construction of one of the individual secondary generators. Fig. 3 is a cross-section of the same.

Referring to Fig. 1, D represents a source of electric energy, which may be a dynamo-electric machine or other proper apparatus for producing alternating electric currents. Two secondary generators (which are a sufficient number to illustrate the principle of the invention) are shown at R and R'. These have their primary conductors *p p* connected in parallel between the main conductors P and N, which extend from the terminals of the source of electricity D. Groups of lamps are shown at L and L', placed in parallel and included in the secondary circuits *s s* of the respective secondary generators.

In order to obtain the counter electromotive effect which I have mentioned, I employ a secondary generator in which the size of the iron core and the length of the primary coil surrounding it are proportionate to the electromotive force applied thereto. An example of such a secondary generator is illustrated in Figs. 2 and 3. This consists of a core of soft iron composed of iron wire in the form of an endless ring, upon which two coils of insulated wire are wound. One coil constitutes the primary and the other the secondary conductor of the secondary generator. I have shown the primary coil wound in sections *p p p p* and the secondary in sections *s s s s* arranged alternately upon the cores. When two or more such secondary generators have their primary conductors connected in parallel arc and their secondary circuits disconnected or open, the counter electromotive force is so great that practically no current passes through the primary conductors; hence when no work is being done in the secondary circuits little or no energy is wasted. When, however, the secondary circuit of any given secondary generator is closed through a greater or less number of parallel branches containing lamps or other translating devices, then a secondary current is generated in the secondary wire, the effect of which is to neutralize the counter electromotive force proportional to the amount of work being done. These changes take place without modifying the value of the current traversing the primaries of the other secondary generators or affecting in any way the operation of the translating devices in their secondaries. The same is equally true of any of the other secondary generators or any number of them connected in the same manner, and it follows that the system is an automatically self regulating as well as a very economical one.



FIGURES IN THE KENNEDY PATENT.

I claim as my invention—

The method of distributing and regulating alternating electric currents by secondary generators, which consists in producing in two or more derived circuits constituting the primaries of two or more secondary generators a counter electromotive force which, when any secondary is open, is practically equal to the applied electromotive force in its primary and in controlling said electromotive force by the current flowing in the corresponding secondary when the secondary is closed in such manner that the current in the primary shall vary with and be approximately inversely proportional to the resistance in the secondary, substantially as described.

In testimony whereof I have hereunto subscribed my name this 27th day of August, A. D., 1889. RANKIN KENNEDY.

THE INCANDESCENT LAMP INJUNCTION.

Judge Wallace Grants a Respite.—Synopsis of the Proceedings.

ON Thursday, July 23, counsel appeared before Judge Wallace in chambers of the United States Circuit Court, to decide upon the settlement of the decree in the incandescent lamp case. Messrs. R. N. Dyer, G. P. Lowrey and S. B. Eaton appeared for the Edison Company, and Messrs. S. A. Duncan, L. E. Curtis and E. Root appeared for the United States Company.

Mr. Lowrey said that complainant was before his Honor with a judgment about to be entered, and a decision against the United States Company, and that company alone. That company was not a manufacturer, but a purchaser from the Sawyer-Man Company of the lamps with which it supplied its customers. Defendants had prepared affidavits with a view of inducing his Honor to suspend the injunction on account of public inconvenience. He thought there was no occasion for his Honor even to consider whether the operation of the writ of injunction ought to be suspended in the interest in some party differently situated. An order restraining defendants from carrying on the business would have no necessary effect upon the public, because lamps were made by others, who were competent until restrained, to supply them. Complainant expected to come to his Honor by-and-by to have one of those manufacturersres trained and expected then to meet all those reasons.

Gen. Duncan and Mr. Lowrey then handed to the court the forms of decrees which had been drawn respectively by counsel for complainant and for defendant.

Gen. Duncan in reply, briefly adverted to the operations of the United States Company. It had established in the United States some 1,050 incandescent plants, having a capacity of 350,000 lamps, and employing a little army of men. In most cases the United States Company were under contract to keep these plants supplied with lamps. Mr. Lowrey had strongly hinted that an injunction against the United States Company would be followed by applications for injunctions against all other manufacturers of incandescent lamps, which would involve a very serious grievance to the public. In New York 45,000 lamps were being operated upon the Westinghouse alternating system, which had been introduced about 1886, at a time when it was supposed, under the law as then interpreted, that the patent in suit had expired. Complainants' affidavits went to show that the Edison Company were not prepared to make satisfactory 50-volt lamps for the alternating system; perhaps for the reason that it was necessary, in lamps of low voltage, to make use of hydro-carbon treatment, a process owned and controlled by the United States Company, subject to certain contract arrangements with the Westinghouse Company. Moreover, the alternating systems served a territory not reached at present by the Edison plants. If by reason of an injunction, such plants were debarred from securing a supply of suitable lamps, the result would be the destruction of all the property invested in them. In view of the quiescence—he might say the acquiescence—of the Edison Company, from 1880, when defendant was publicly known to have been actively engaged in developing an incandescent lighting business, down to the time the suit was brought, he believed that if the bill had set forth the facts, a demurrer to the jurisdiction of the court would have lain. Mr. Hebard had said in his affidavit, that if the suit had been brought at once when the infringement began, and prosecuted promptly to a decision on its merits, defendant's investment in that branch of business would not have reached $50,000; whereas at the time the suit was brought it had reached $2,500,000, three-fourths of which had to do with incandescent lighting.

His Honor said that he had decided that complainant was entitled to an injunction; the only question was whether there were considerations which ought to lead to its suspension pending a decision by the appellate court. There might be a case, for instance, where the recovery of the royalty would be sufficient to indemnify for the infringement of the patent, while at the same time the granting of an injunction might cause tremendous inconvenience. What had influenced him very much, in the impression he had in the matter when he decided the case, was the circumstance that there had been a long delay in the prosecution of the suit, and the additional circumstance that the patent was one very well calculated to engender doubt in the minds of people who were making incandescent lamps as to whether it was good for anything, and then there was the fact that during this time a large amount of capital had been invested and a great many men were employed in making the lamps,

Mr. Lowrey said they had not expected that this question would arise here as against the complainant, and that he would rather not have it determined at this time, nor in this way, because he had not said what he had to say upon it.

His Honor remarked that if some one had a right to set up this patent against infringers, they should have commenced early and in the right time.

Mr. Lowrey said that people had not thought it worth while to spend their money, until the decision in Bate and Hammond had let them out. There had been no delay since then. No man was to blame when the law told him, "You have not got a right," for not prosecuting that right, if he had proceeded vigorously when the superior authority told him he had the right.

Mr. Root, for the defendant, said that the patent had been alive for five years, irrespective of Bate and Hammond, and the proof had showed that the agents of defendant had over and over again said to representatives of complainant, "Why don't you sue if you say this patent is controlling?" Defendant could not get into court.

Mr. Lowrey said he would read from Mr. Hebard's affidavit, in the light of the distinction that he should ask his Honor to make between acquiescence and not suing. The gentlemen had not been misled by acquiescence; they had thought they would not be pursued at law; they had misjudged, and now they wanted to get, as the reward of that misjudgment, what the court allowed people who had been misled—a very different thing.

His Honor said he was not thinking about acquiescence. Where parties did not assert their rights for several years, it looked as if they did not feel, either that there was any necessity for it, or that they had any rights.

Mr. Lowrey said that judicial discretion was governed by established rules, and that its exercise outside of an established rule was an error. It rested on two things, one the right of the party, growing out of laches or acquiescence of the party who pressed against him, and the other public inconvenience.

His Honor mentioned a case in the Supreme Court, where a stay had been granted, because great injury to the defendant would have resulted from an injunction and this without reference to the public rights at all.

Mr. Lowrey said defendants contended that they had put up a great many plants that would become valueless if they could not get lamps; but there was no difficulty in getting lamps from others; there was nothing justifying the application of those benevolent principles of law. He did not suppose his Honor was there to protect defendants from paying damages, which might be measured by the cost of going round the corner and buying the lamps in another shop. Complainants were entitled to this injunction by the force of logic, and nothing intervened to destroy the effect of that logic, because of the curious situation defendant was in.

Mr. Root said defendants would meet the real substance of the thing here. At some other time, before some other judge, complainants might ask for an injunction against some other company, and his Honor's decision refusing to stay this injunction would be presented as a sufficient reason why a preliminary injunction should issue. Defendant was under contract to deliver lamps, and procured them to be made by a licensee in order to deliver them. Defendant was under these great pecuniary obligations; with large amounts invested; with many corporations and individuals from the public involved; led into that position by the failure of complainant to bring the validity of this patent to an issue at a time when defendant could not bring it to an issue. Mr. Root then referred to the case of *Mackall* v. *Casilear* (137 U. S., 556), in which the bill had been dismissed on demurrer for want of equity, upon the sole ground of laches. The Supreme Court had there said that mere protest and assertions of right, and threats not followed by effective action, could have no effect whatever. The proofs showed that complainants had been fully aware of an active, vigorous competition during the entire time which had been supposed to be the life of this patent, and it now appeared by what had been said in regard to this cloud which hung over the patent that they—

His Honor interposing, said that he thought that the greatest cloud that hung over the patent was in its claims—in the language of the patent itself. He did not much blame any infringer for assuming that he could go on and make any sort of an incandescent lamp without fear of that patent. He noticed that no two judges who had had it before them had ever agreed about it. Perhaps two had; but only one delivered an opinion; if they had both delivered opinions, he presumed they would not have agreed. He was practically called upon to suspend this injunction for about six months, and he thought, in view of the facts that the suit had not been brought for five years after it could have been brought; that there was a fair doubt as to whether his own decision would be affirmed; that a large investment had been made by those who had probably thought that they could go on safely notwithstanding the decision; and that large numbers of men had been and still were employed in the manufacture of these lamps—he thought he should be justified, under all these circumstances, in the exercise of his judicial discretion, in suspending the operation of the injunction.

In answer to a question from Mr. Lowrey, his Honor said that the amount of bonds that should be given would be a matter for consideration. The stay would be limited to defendant's specified contracts; not to permit the doing of any new business.

Mr. Root said defendant had some millions of dollars invested in the manufacture of electrical apparatus, and wished to proceed with the sale of it. If the right to furnish lamps were cut off by injunction, the sale stopped, and the manufacturing practically ended; then, in case his Honor's decision were reversed six months hence, defendant's business would have been ruined.

His Honor said that he did not propose to allow defendants to go on and extend their operations; he would simply allow them to live up to contracts already made; he would protect them to that extent; but the decision must stand for something.

Gen. Duncan explained that the large capital was required, not for making the lamps, but for the other apparatus; only about 2¼ per cent. of the cost of a plant was in the lamps, and it was considered desirable that lamps and dynamos should be of the same make. If his Honor were to limit defendant's right of manufacturing lamps for the ensuing 3 or 4 months, defendant's manufacturing industry would be broken up and its skilled workmen scattered to the four quarters of the earth; the best of them would go into the employ of their rivals; and then if defendants were fortunate enough to secure a reversal of his Honor's decree, it would be impossible for them to recover their position. The question was, whether defendants could, by giving a sufficient bond, have protection for this limited period of time; of course this right, reserved temporarily, could be limited to the sale of lamps in connection with dynamos of their own manufacture.

His Honor remarked that he was inclined to be liberal.

Mr. Lowrey said that before being liberal, might his Honor allow him to suggest, that with companies allied as defendant's were, his Honor's liberality might be abused. They had only to transfer their sales of new dynamos to one of the other companies, and the lamp business would be carried on in the largest possible manner. The allowance to supply lamps to dynamos already sold would result in the selling of all the lamps they could get customers for.

His Honor said he was inclined to think that in case complainants get their royalty on all the lamps defendant sold, that they would get justice.

Some discussion then took place between counsel as to the amount of the bond. It was finally agreed that $50,000 would be an equitable amount, and that the United States Company should have ten days' time in which to execute the bond. Judge Wallace then signed the stay of the writ of injunction pending the result in the appellate court.

By the interlocutory of Judge Wallace, filed on the same day, the accounting of the profits of the United States Company, through its use since 1880 of Edison's patented invention, was referred to John A. Shields. The defendant company immediately filed its bond in the sum of $500 for the costs of an appeal from the interlocutory decree to the new Circuit Court of Appeals.

TELEPHONE PRIVILEGES MUST BE THE SAME TO ALL TELEGRAPH COS.—POSTAL TELEGRAPH CO. vs. DELAWARE & ATLANTIC TELEPHONE CO.

The long-pending suit for a writ of mandamus to compel the Delaware and Atlantic Telegraph and Telephone Company to put a telephone in the office of the Postal Telegraph-Cable Company in Wilmington, Del., was decided by Judge Wales in the United States Circuit Court at Wilmington, on Saturday, July 18. The case was originally brought in the Superior Court of the State of Delaware and thence transferred to the Circuit Court. The decision grants the writ of mandamus, but it is possible that the case will be carried to the Supreme Court of the United States, and that it will be a year at least before the Postal receives its telephone.

G. H. Bates, of Wilmington, and R. S. Guernsey, of New York, represented the relators, and Edward G. Bradford, of Wilmington, and Charles L. Buckingham, of New York, the respondents.

The decision is based mainly on the principle that if a patentee leases his inventions for a public, rather than an individual, use, he thereby gives the use to the whole public. In this case, the American Bell Telephone Co. might have licensed its patent to the defendant sub-company, so that it alone could have used it, but the sub-company was licensed to use it for the public, and in fact did so rent it to all who desired, excepting only the Postal Telegraph Co., on the ground of an exclusive contract between the parent American Bell Co. and the Western Union Telegraph Co. Moreover: "The respondent is a common carrier which has offered to the public the use of a telephonic system for the rapid conveyance of oral messages from one point to another; that one of the most important duties of a common carrier is that it shall serve all persons alike, impartially and without unreasonable discriminations, and that the performance of this duty cannot be avoided by a special contract made between the respondent or its licensor and one or more persons for the exclusive use of the system, such contract being void as against public policy, and that a patented device or devices, when employed for a public use, or by a common carrier in the prosecution of its business, will be subjected to the same rules and regulations which govern unpatented property under the same circumstances. The reasons alleged by the respondent for its refusal to furnish the relator with a telephone are therefore insufficient, and it is ordered by the court that the writ of mandamus be awarded."

THE PERKINS SWITCH IN LITIGATION.

A special dispatch from Hartford, Conn., of July 25, says: "Charles G. Perkins, of the Perkins Electric Switch Company, of this city, and the Perkins Electric Lamp Company, of Manchester, has a big suit against the Edison General Electric Company, of New York. Mr. Perkins said last night that the electric switch which the Edison people are manufacturing was patented by him in 1881. He understands that there have been 400,000 or 500,000 of these switches made by the Edison Company. The royalty due him on them would be about $100,000. He says that the Edison people admitted to him that they were manufacturing the switch which he patented. The case will come up in the September term of the Superior Court. Mr. Perkins has retained Charles L. Buckingham, of New York, as his attorney."

"BY FAR THE BEST."

In ordering some special copies of THE ELECTRICAL ENGINEER of recent date, a subscriber writes: "I want to bind in the arguments and decision in the Filament Suit, with my set of briefs. This is by far the best digest of the arguments."

J. H. BUNNELL & Co. have brought suit against the Manhattan Electric Supply Co., of this city, for alleged infringement of their Burnley dry battery.

THE BRUSH STORAGE BATTERY PATENT SUSTAINED.

THE BRUSH ELECTRIC CO. *vs.* THE ELECTRICAL ACCUMULATOR CO.

On July 23, Judge Coxe, of the U. S. Circuit Court for the Southern District of New York, handed down his decision in the above suit sustaining the Brush patent, and granting an injunction. The following gives all the main points of the decision:—

This is an equity action founded upon three Letters Patent, granted to Charles F. Brush for Improvements in Secondary Batteries, as follows: No. 337,299, granted March 2, 1886; No. 260,654, granted July 4, 1882, and No. 266,090, granted October 17, 1882.

These patents and one other, No. 337,298, granted March 2, 1886, were before this Court in *Brush Co.* vs. *Julien Co.*, 41 Fed. Rep., 6979. The Court there decided that No. 337,298 and No. 337,299 were for the same invention, and intimated, as the inventor and his expert apparently regarded the former as the broader patent, that the difficulty might be met by a surrender of the latter, or by a disclaimer of similar claims therein. This solution of the difficulty was thrown out as a suggestion merely, the final disposition of the patents being left till the settlement of the decree.

It was not the intention of the Court to decide that one of these patents was entitled to preference over the other. For the reason stated, and for convenience of illustration, No. 337,298 was given prominence in the discussion, but the conclusion would have been the same had the position of the patents been reversed.

Upon the settlement of the decree the complainant selected No. 337,299 as the patent upon which it chose to rely, and withdrew No. 337,298 from the consideration of the Court. This was done without objection by the defendant in that case. On the 15th of July, 1890, after the decree in the *Brush-Julien* case was entered, the complainant withrew No. 337,298 from this cause and an order was entered dismissing the bill as to that patent. The cause has since proceeded upon the three patents as stated.

In the prior litigations involving the subject matter of these patents the following propositions have been decided:

First.—That Mr. Brush was the first in this country to hold absorptive substance, in the form of dry powder, in place on the supports of a secondary battery by paper or equivalent material, and the first who rammed or pressed it into grooves or receptacles in the plates.

Second.—That No. 337,298 and No. 337,299 are for the same invention, and that the complainant was not entitled to both patents, but was entitled to one.

Third.—The complainant having elected to hold No. 337,299, it was decided, by the decree, that claims numbers one, two, three, six, seven, eleven, twelve and thirteen were valid, the word "perforations" in claims numbers six and seven being construed as synonymous with "cells or cavities."

Fourth.—That the claim of No. 260,654 was not infringed by the application of the absorptive substance to the grids by a trowel or spatula.

Fifth.—That the defendants, by the use of supports filled with rows of uniform square holes, did not infringe the "rib claims" of No. 266,090.

Sixth.—That claims numbers seven and fourteen of No. 266,090, the latter claim being limited to the "perforations" described, were valid and infringed.

Seventh.—That No. 337,298 (and by implication No. 337,299) was not invalidated by patents Nos. 261,512 and 261,995, granted to Mr. Brush, July 18 and August 1, 1882, respectively.

Eighth.—That No. 337,298 (and by implication No. 337,299) was not invalidated by the expiration of the Brush Italian patent. *Brush* vs. *Julien*, 41 *Fed. Rep.*, 679; *Accumulator* vs. *Julien* 38 *Fed. Rep.*, 126.

All of these conclusions were reached after careful study and mature deliberation, and now, after having been re-examined in the light of the present record, arguments and briefs, except as to claims numbers eleven and thirteen of No. 337,299, are reaffirmed. No useful purpose would be subserved by again discussing them, as such a task would only involve a repetition of what has been said already in the other cases.

The proof of infringement is substantially the same as in the *Brush-Julien* case. It is more complete as to the manner in which the active material is applied to the plates, but in this respect it only emphasizes the former decision as to the non-infringement of the claim of No. 260,654. That claim is as follows:

"The method of forming the plates of a secondary battery, consisting in forming receptacles for oxide of lead in its surface, then applying oxide of lead to the plate and within such receptacles, and afterwards subjecting the oxide of lead to pressure."

The claim clearly contemplates not only the treatment adopted by the defendants, but *afterwards* subjecting the oxide to pressure. The defendants apply the oxide to the plates and within the receptacles with a wooden trowel in the hands of the workman, and there they stop. They do not subject the oxide to pressure afterwards.

The questions arising upon the expiration of the Italian patent, and as to the validity of the "red lead claims" are, however, presented by this record in a new and different aspect and may, with entire propriety be examined *de novo*, together with the question, not heretofore considered, relating to the effect of the Brush patents Nos. 260,653 and 276,155 upon the broad patent in suit.

First.—It is thought that claims numbers eleven and thirteen of No. 337,299—the red lead claims—are void for lack of invention. The specification, after referring to lead oxide as the active material, which is primarily and mechanically applied to the plates, proceeds:

"Peroxide is the best oxide of lead to use in the preparation of the plates; but as this is rather expensive to prepare, red lead or minium may be used."

If the record contained nothing but this statement the claims could not be upheld. After the invention of a support primarily coated with mechanically applied oxide of lead, merely coating the plate with the commonest, cheapest and best-known form of lead oxide did not require the exercise of the inventive faculties. Especially is this so when the patentee himself asserts that the best results can be obtained by using peroxide. It would seem that the use of red lead would at once occur to any one who had even a superficial knowledge of the art. There is no more novelty in using red lead for the coatings than there is in using cast lead for the plates. (*Brush* v. *Julien, supra, p.* 692.)

Patent No. 337,399, at least as far as its broad claims are concerned, is not invalidated by anything contained in the Brush patents No. 260,653 and No. 275,155. The application for the former (No. 260,653) was filed June 15, 1882, a year and two days after the application of No. 337,299.

No one can read the specification of No. 260,653 without being impressed with the fact that the inventor intended to confine the patent to a single point, namely the form of the electrodes. He expressly says so.
The claim is:

"In a secondary battery, an element consisting of a structure of etagère-like form, containing in the spaces between its shelves lead in a finely-divided state, substantially as set forth."

It is true that the broad invention is described, but it is equally true that it is not claimed. It was hardly possible for the patentee to describe the subsidiary invention without disclosing his main invention. An infringer, with the statements on the face of No. 260,653 before him, would scarcely have the hardihood to assert that he supposed the broad invention was released. No court would listen to such a plea. The claims of that patent did not protect Mr. Brush in the use of the broad invention. A person who did not use an "etagère-shaped" plate, could, if no other patent prevented, use the broad invention with perfect impunity. No. 337,299 was intended to prevent such use. The court has not been able to discover an authority holding a broad patent invalid in such circumstances. None has been cited by counsel.

What is true of No. 260,653 is also true of No. 276,155. Mr. Brush was the first in this country to make the broad invention as stated above. He is entitled to the fruits of his invention. It is the policy of the law to reward him.

Where the Court can see that the patentee has produced an invention of real merit, it should not be unduly industrious in endeavoring to discover some statement or act of his by which, on technical grounds, his rights may be forfeited. It should rather be sedulous to protect him. Whether or not the improvements patented by Nos. 260,653 and 276,155 are the same as the improvements covered by some of the claims of Nos. 337,299 and 266,090 it is, perhaps, unnecessary to decide, for none of the claims in issue and infringed are so affected.

It seems that in his anxiety to claim his invention in every conceivable form, the patentee has involved himself in a labyrinth of descriptions and claims in which electrician and lawyer alike are quite apt to become confused. What Mr. Brush accomplished in 1879 and 1880 can be embraced in a brief, clear and concise statement. What he actually did is the test by which his patents may be judged. He is entitled to what he invented and only this. His patents can receive no broader construction, because he described his inventions with irksome prolixity and gives to the same structure a wearisome variety of names. The nomenclaturist should not seek the reward for his labors in the Patent Office. A person is not entitled to a patent because he has invented a new word. The danger and impropriety of holding a number of claims relating to the same structure, and which can be differentiated only by the most abstruse and metaphysical distinctions, seem apparent. They are calculated to embarrass the inventor and mislead the public.

Did Patents Nos. 337,299 and 266,090 expire with the Italian patent?

The Italian patent was applied for July 28, 1882, sealed August 8, 1882, and was issued for a term of three years from September 30, 1882. It expired September 30, 1885, never having been prolonged, renewed or extended. No. 337,299 was granted March 2, 1886; No. 266,090, October 17, 1882; both were applied for in June, 1881.

Under Section 4,887 of the Revised Statutes, the test of identity between the foreign and the domestic patent, as established by the Supreme Court in two recent decisions, may be stated as follows:

Is the principal invention in each, is the thing patented abroad the same in all essential particulars as the thing patented here; would the home patent be infringed by a structure made in accordance with the provisions of the foreign patent?

In cases where these questions are answered in the affirmative the United States patent falls, and it will not be saved by the fact that it contains improvements not found in the foreign patent. *Siemens* vs. *Sellers*, 123 *U. S.*, 276; *Com. Co.* vs. *Fairbanks Co.*, 135 *U. S.*, 176.

Whether the expiration of a foreign patent for an improvement only will operate to overthrow a domestic patent for a broad invention, which contains also a claim covering the improvement, has not apparently been decided by the Supreme Court. The language of the Court in *Siemens* vs. *Sellers, supra*, is, perhaps, comprehensive enough to cover such a contingency, but this is a question which need not now be considered.

In the *Brush-Julien* case the Court commented upon the absence of expert testimony relating to the Italian patent. No similar observation can, with propriety, be made regarding the present record. It would indicate a lamentable want of appreciation on the part of the Court to ask for additional instruction and advice. Eight experts of greater or less prominence and attainments have testified upon this subject. Three of these, called by the defendants, have expressed the opinion that the divisions of the Italian patent describe everything claimed in the United States patents granted to Mr. Brush and that the inventions covered by the two patents, No. 337,299 and No. 266,090, are literally described and substantially claimed in the Italian patent.

On the other hand, five electricians, including the patentee himself, have testified that the Italian patent relates to inventions wholly different and proceeds upon totally dissimilar lines. In short, that it is but a progressive step in the Planté method, its object being to aid the process of electrical disintegration of the plates in the electrolyte, and not to supersede that process by placing the active material mechanically upon the plates prior to immersion in the battery fluid.

The mere fact that these gentlemen of conceded ability and learning, whose motive is to enlighten the Court, and who were all sworn to tell the truth, differ so radically regarding the meaning of the Italian patent, is of itself suggestive.

The defendants plead the defense of forfeiture. They must prove it by a preponderance of evidence. And yet upon the question of the identity of the patents in question there is a sharp difference of opinion among those who are most entitled to speak upon the subject. Is there not room for the assertion that the defendants have failed to sustain the burden in this behalf?

When this question was presented in the *Brush-Julien* case the mind of the court was in doubt, and now, having re-read the Italian patent in the light of the new testimony, it is still in doubt, but inclining more strongly to the opinion that the complainant's contention is correct. The Court is not prepared to hold, therefore, that the Italian patent is for the same inventions as those covered by the two patents in question. In fact, the more the Italian patent is studied, the more settled becomes the conviction that it is not for the same invention as No. 337,299.

Believing that Mr. Brush is entitled under our law to protection for a meritorious invention, the Court should not, unless fully convinced that the facts warrant such a course, destroy his patents upon grounds which do not go to the merits of the invention, and which, for want of a more accurate word, may be termed *technical*. Why a meritorious inventor, who is a citizen of this republic, should lose his rights at home because he has tried to protect them abroad is, on principle, not easy to comprehend.

It is said that the expiration of the Italian patent threw the invention into public domain. So it did into the domain of the Italian public, but if Mr. Brush had taken no patent in Italy the Italian public could have practiced the invention from the moment it became known there. Had he taken no foreign patents his invention would have been thrown into the public domain of every land but this. In this country his inventions would have been protected for seventeen years, outside of this country they could have been used with perfect impunity. The inventor applied for his patent here long before he applied abroad, but through the delay of the Patent Office the foreign patents were issued first.

Assuming the invention to be similar, the inventor has been guilty of no fault, the American public has lost no rights, and yet, under the provisions of this statute, which it is thought was never intended to apply to a case like this, a valuable monopoly is destroyed.

The question of how to dispose of No. 337,298 is, in view of complainant's position regarding it, more puzzling than ever. The rule which obtains in this circuit, requiring a disclaimer of invalid claims as a condition of a decree, has always seemed an arbitrary one. It certainly seems inequitable that the Court, at *nisi prius*, should compel the patentee to renounce forever a claim which may be held valid upon appeal. It is possible that this rule may be modified by the Circuit Court of Appeals.

In view of this contingency and of the extraordinary and distinguishing circumstances surrounding this case, the Court has concluded, if the complainant upon reflection still desires to assume the responsibility of retaining two patents for the same invention, not to require a surrender or disclaimer of No. 337,298 as a condition of a decree. It is thought, however, that pending an appeal it should be deposited with the clerk to await the further order of the Court.

An accounting having been waived, it follows that on filing a disclaimer of claims eleven and thirteen of patent No. 337,299, the complainant is entitled to a decree upon claims one, two, three, six, seven and twelve of this patent, and upon claims seven and fourteen of No. 266,090, for an injunction, but without costs.

W. C. Witter and W. H. Kenyon, for the complainant; Fred. H. Betts, for the defendant.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JULY 14, 1891

Accumulators:—

Secondary-Battery Plate, J. R. Maclaughlin, F 455,968. Filed June 3, 1890.
Plate is composed of opposite end-bars, and transverse connecting bars, all of aluminum; the connecting bars are of hollow trough-like form with in turned edges, adapted to receive and hold active material.

Alarms and Signals:—

Thermostat, H. A. Chase, 455,788. Filed Oct. 29, 1888.
A circuit-changing lever is normally pressed by a spring against a block of paraffine or other easily fusible material adapted to melt at a given temperature.

Fire-Alarm Apparatus, H. A. Chase & H. F. Eaton, 455,812. Filed July 28, 1887.
A receiving apparatus adapted to the detection of false alarms from thermostats.

Thermostat, H. A. Chase & H. F. Eaton, 455,813. Filed Nov. 1, 1888.
Adapted for use in a closed circuit and arranged to open the circuit and thereafter close it again.

Signaling Apparatus, H. F. Eaton, 455,873. Filed Sept. 23, 1889.
Amplification of the invention patented to B. J. Noyes, Mar. 22, 1887, No. 359,688. Adapted to police signaling.

Conductors, Conduits and Insulators:—

Process of Manufacturing Insulated Conductors, C. Cuttriss, 455,789. Filed Aug. 6, 1890.
Consists in applying to, or winding upon, a conductor the loose fibres of a material such as cotton, and compacting them to form a felted or matted sheathing. The fibrous sheathing may be saturated or coated with a fusible insulating compound.

Insulated Electrical Conductor, E. D. McCracken, 455,904. Filed Mar. 5, 1891.
Winds a conductor with a paper tape composed of twisted paper or paper cord flattened.

Wire-Covering Machine, J. McCahey, 455,970. Filed Sept. 12, 1890.

Insulated Electric Conductor, E. D. McCracken, 456,120. Filed Mar. 4, 1891.
Employs air spaces for reducing static capacity. An insulating cord is wound round the conductor spirally with considerable space between each turn; an exterior insulating coating is afterwards applied.

Dynamos and Motors:—

Electric Motor, H. H. Porter, 455,765. Filed Jan. 17, 1891.
Has a three-pole armature revolving between two pole-pieces, obviating a dead point.

Alternating Current Motor, W. Stanley, Jr., and J. F. Kelly, 455,773. Filed April 10, 1891.
Employs a condenser, with a shunt-wound machine, to neutralize the effects of self induction.

Dynamo-Electric Machine or Motor, J. B. Entz, 455,790. Filed Nov. 24, 1890.
Relates to machines in which the field magnet system is situated within a ring armature, and in which either the field-magnets or the armature may be the rotating part.

Holder for Carbon Brushes of Commutators, C. H. Farrington, 455,856. Filed Oct. 21, 1890.

Armature for Dynamo-Electric Machines, E. W. Rice, Jr., 455,887. Filed Mar. 21, 1891.
Relates to means for holding the coils in place.

Electric Motor or Dynamo-Electric Machine, C. G. Curtis, 455,898. Filed Mar. 9, 1891.
A construction for multipolar machines adapted to reduce the vertical dimensions; especially applicable to street car motors.

Armature for Dynamos, F. L. McGahan, 455,971. Filed Dec. 26, 1890.
Relates to method of driving: armature is provided with an external friction rim, enabling it to be driven peripherally by a friction wheel.

Galvanic and Thermo-Electric Batteries:—

Terminal for Electric Batteries, H. V. Hayes and A. S. Hibbard, 455,986. Filed Jan. 19, 1891.
Employs an easily fusible soldered joint in lieu of thumb-screw connections.

Lamps and Appurtenances:—

Electric Cut-Off Apparatus, E. W. Rice, Jr., 455,800. Filed Dec. 15, 1886.
Contacts are separated by an insulating film and adapted to come together upon the destruction of the film through the heat of an arc abnormally formed.

Measurement:—

Electric Indicator, E. C. Eldredge, 455,855. Filed Feb. 9, 1891.
For current measurement.

Medical and Surgical:

Electro-Medical Lighting Apparatus, P. Oudin and H. O. Kratz-Boussac, 455,972. Filed Oct. 13, 1890.
For illuminating the different natural cavities of the human body for medical examination.

Apparatus for Administering Electricity, G. H. Bethel, 455,981. Filed Oct. 13, 1890.
Apparatus for electric medical baths.

Electric Belt, L. N. Fancher, 456,021. Filed April 6, 1891.

Metallurgical:—

Electro-Magnetic Ore-Separator, J. Wenstrom, 455,808. Filed Dec. 24, 1890.
Improvements on machines of the type patented to the same inventor Nov. 15, 1887, No. 373,211.

Magnetic Separator, J. Wenstrom, 455,809. Filed Dec. 24, 1890.
Further improvements, as next above.

Magnetic Separator, H. G. Fiske, 455,984. Filed Mar. 26, 1891.
Feeds the gangue through or across a magnetic field in a film or stream of regulated thickness.

Magnetic Ore-Separator, H. G. Fiske, 455,985. Filed Mar. 26, 1891.
Employs a feed belt or conveyor, a transverse belt or separator crossing the feed belt a short distance above the latter and a series of magnets with their poles in close proximity to the separator; the magnet poles alternate in polarity in the direction of the motion of the separator.

Miscellaneous:

Loop-Switch, W. M. Goodridge, 455,747. Filed Mar. 4, 1887.

Electro Phonometer and Phonoscope, I. H. Farnham, 455,815. Filed Feb. 13, 1891.
An apparatus for investigating disturbing currents, as upon telegraph or telephone lines, and for comparing their effects.

Electric Switch, C. G. Dahlgren & J. H. Svensson, 455,837. Filed Dec. 24, 1890.
A quick-acting switch.

Cut Out for Arc Lamps, C. E. Scribner, 455,953. Filed Nov. 4, 1890.

Lighting Arrester, C. S. Van Nuis & J. H. Vail, 455,955. Filed Oct. 16, 1890.
Relates to arresters of the class employing several fusible wires arranged to be thrown into circuit successively and automatically.

Railways and Appliances:—

Subway and Connection for Electric Railways, W. Osner, 455,763. Filed Oct. 13, 1890.
Uses the track rail as part of the structure of the conduit.

Electric Railway, R. M. Hunter, 455,796. Filed May 22, 1886.
A telpherage system.

Trolley for Electric Cars, W. H. Knight, 455,798. Filed Apr. 8, 1891.
Provides for sounding an alarm when the trolley wheel has run off the conductor.

Street-Car, F. W. Smith, Jr., and S. S. Williamson, 455,842. Filed Feb. 16, 1891.
In a car propelled by a local motor means are provided for arresting the movement of the car without stopping the revolution of the motor or of the driving-wheels; the car may be raised and supported independently of the driving-wheel.

Electric-Railway System, S. P. Wilcox and J. D. Partello, 455,956. Filed June 16, 1890.
A conduit system; includes the employment of conductors in sectional lengths in the conduit and a pair of continuous feeding conductors along the system.

Street or Station Indicator, W. T. Snedden, 456,006. Filed Jan. 14, 1891.

Railway Time-Signal, J. C. Dickover and W. Scott, 456,023. Filed Feb. 24, 1891.
A train register.

Street or Station Indicator for Cars, G. H. Tietjen, 456,098. Filed Jan. 20, 1890.

Motor-Truck for Elevated Railways, E. M. Turner, G. L. Van Beek and L. A. Brown, 456,103. Filed Oct. 2, 1890.
Adapted to a three-rail system in which the car is suspended from the upper rail.

Telegraphs:—

Automatic Circuit-Closer for Telegraph-Keys, J. W. Brown, 456,110. Filed Apr. 16, 1891.

PHILADELPHIA NOTES.

A LITTLE BASEBALL.—For some time past it has been evident that the employees of Partrick & Carter Co. were going to have a bad attack of baseball fever. The symptoms developed very rapidly and culminated in nines being selected from the store and factory, and the game was played on July 15, with the following result: Store 29; factory 11. It will be seen by the score that the factory was nowhere, which is easily accounted for when it is stated that Mr. Townsend was in the box for the store. He worked as hard as he would if he were chasing a $1,000 order, and the balls he pitched were of such high resistance that the heavy hitters of the factory couldn't get up enough voltage to make more than two safe hits, all their runs being made through leakage.

THE PARTRICK & CARTER CO. report business as very good for this season, their trade thus far being in advance of 1890 for the same period. Their King annunciator is a big success; the large dealers are having so many calls for them that they are making them a part of their regular stock. The new annunciator invented by F. S. Carter will be ready for the market very soon. It will unquestionably be the best thing in that line ever introduced by this firm, and will meet with the indorsement of the trade everywhere.

MR. J. W. PARKER has placed a 100 h. p. Ball engine with complete steam plant at the store of George Kelly & Co., Market street, which will operate a large arc light plant. He also placed an 80 h. p. Ball engine for the Ivy Brick Co., Ivy City, Washington, D. C.

MR. H. C. ROBERTS, of Vallee Bros. & Co., is in New Castle, Va., superintending the starting of an electric light plant which the above company has just installed in a large hotel recently erected in that town.

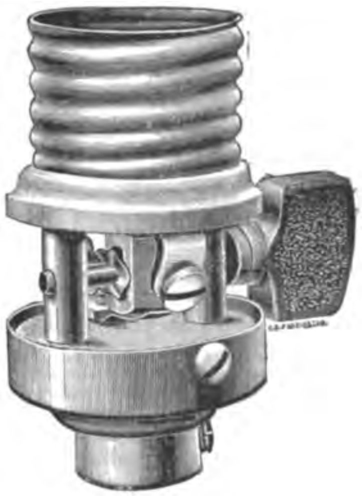
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Sweet are the uses of advertisements.—Mrs. Partington.

THE C. E. M. LAMP SOCKET.

THE accompanying engraving illustrates a new and improved lamp socket recently invented and manufactured by the Consolidated Electric Manufacturing Company, of Boston. The improvement consists in the method of making and breaking the contacts, so as to produce a quick and positive action, and so that the key is at all times either "on" or "off." This is done by means of a cam on the contact piece with four indentations into which a snap-spring fits, making the key turn quickly and preventing



THE C. E. M. LAMP SOCKET.

all possibility of short circuit or poor connection. The parts of the socket are all brass with porcelain insulation, and the workmanship is good and reliable. Already a number of large orders have been received, though the socket has but recently been put on the market, and the Consolidated Company are in receipt of many warm testimonials of its merit.

NEW ENGLAND TRADE NOTES.

MR. F. DAY VOORHEES, of the Norwich Insulated Wire Company, of New York, was in Boston this week, and reported good business in insulated wires. The Holtzer-Cabot Electric Company of Boston, have taken the agency for the Norwich insulated wires, and are already sending in large orders. The Norwich company have two factories in Brooklyn, but these are so overloaded with work, that they are now looking around for another factory, so as to increase their facilities for the fall trade. Their business in telephone cables alone is very large, nothing yet having been invented with so large an insulating resistance or so small an inductive capacity; but in addition to this staple line of goods the Norwich company are manufacturing large amounts of high insulation underground wires for electric light purpose, and are introducing a high grade line wire, which they are able to offer at very reasonable prices. They are also manufacturing a perfectly waterproof magnet wire and all kinds of house wires, which in addition to being waterproof are also thoroughly fireproof.

H. N. BATES & CO., of Boston, are having a large run on their goods for the equipment of central stations and other electric light plants, where first-class workmanship is required. Messrs. Bates & Company are sole selling agents for the United States of the famous Hunter friction clutch. Among their most recent contracts are the following: The new central station of the Concord Gas Company, Concord, N. H., which they are equipping complete with shafting, pulleys and friction clutches; the Woonsocket Electric Machine and Power Company, complete equipment of shafting, etc.; the Augusta, Hollowell and Gardner Electric Street Railway Company, Hollowell, Me., complete equipment of shafting, etc., and they are now engaged in remodeling the whole electric light plant of the Boston Post Office, installing Hunter friction clutches throughout.

THE SAFETY ELECTRIC LIGHT COMPANY, of Boston, which has for the past few months been making experiments with a primary battery for electric lighting, has so far perfected its battery as to put it to several practical tests that seem clearly to demonstrate its commercial value. The particular field in which the company has been working is the lighting of steam railroad cars, and several exhaustive and successful trials have been made by lighting the cars on long railroad trips. This week the directors' car of the New York and New England railroad, which has recently been equipped with the battery, made a short trip, affording an opportunity of witnessing the burning of the lights. There were eighteen lamps used, each of sixteen candle power, and these illuminated the parlor, the different staterooms, the kitchen and the other parts of the car. The battery cells were carried in a neat box beneath the car floor, and the place was so arranged that the cells could be removed and charged with fresh solution with very little difficulty. The wires from the battery lead to a convenient place in the interior of the car, where is located the switchboard, and from here the lamps on the different circuits can be lighted as well as turned to any degree of brilliancy from one candle to sixteen. The Safety Electric Light Company has been very conservative in its operations and is making every possible test to demonstrate the practicability of its light before placing it on the market. The trip last evening was most successful in every way.

THE UNION ELECTRIC MANUFACTURING CO., of Bridgeport, Conn., have now got thoroughly ready for business, and have already placed on the market a very handsome lamp socket and rosette, illustrated in our last issue. They are now manufacturing and will have ready for sale very shortly an excellent double-pole switch, which does not in any way conflict with existing patents. Their business is opening up in very good shape, though the company as yet are very modest in their reports, but well satisfied with what they have already done. The company are in receipt of numbers of letters of testimonial, and promise to the trade a line of goods which do not require *to be returned.*

MR. WILLIS L. ADAMS, of the Electric Merchandise Company, of Chicago, was in Boston, this week, looking up a number of his customers and friends in the interests of his company. In the midst of his calls he found time to drop into the Boston office of THE ELECTRICAL ENGINEER.

THE PETTINGELL-ANDREWS CO. report that they have decided *not* to go into the proposed combination to be known as the United Electric Company, which was outlined in our issue of July 8th. They will continue to do business as formerly under their own title.

WESTERN TRADE NOTES.

THE NEW CHICAGO HERALD BUILDING have placed an order with the Western isolated lighting department of the Thomson-Houston Electric Co. for a plant consisting of one 10,000 and one 15,000-watt arc dynamos with 50 double-carbon arc lamps, which will be novel in some respects. Special permission was obtained from the city electrician for the concealing of the arc light wires in this building, and a high grade of rubber-covered wire will be used, protected by "Interior Conduit" and laid in the cement flooring. A circle of six lights will be placed on the flagstaff so arranged that they can be raised or lowered at will with perfect ease by one man.

Special fixtures for suspending the arc lamps, a number of which will be placed on the front of the building, have been designed, and the wires leading to these fixtures will be brought through the building front. In order to accomplish this it will be necessary to drill in some places through five feet of brick and terra cotta, and in other places through about three feet of solid granite.

THE CHICAGO ELECTRIC MANUFACTURING CO., 73 W. Jackson St., Chicago, have just fitted up a very complete and elaborate testing-room for the calibration of ammeters, voltmeters and electrical testing instruments of all kinds. They are also making a specialty of electrical instrument repair work, and have excellent facilities for carrying on this branch of business with promptness and in the best possible manner. They are doing a large business in the manufacture of general electrical supplies and in experimental apparatus.

MR. WM. HOOD, dealer in electrical specialties, and Western agent of the Accumulator Company, is meeting with great success with the Jewel incandescent lamps, for which he is agent. His attractive exhibit in his handsome store window on La Salle street is exceptionally catchy, and must be seen to be appreciated.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE

Electrical Engineer.

A WEEKLY REVIEW OF THEORETICAL AND APPLIED ELECTRICITY.

Vol. XII. No. 170. NEW YORK, AUGUST 5, 1891. Price 10 Cents.

For Contents, see Page V.

Press of C. C. SHELLEY, 10 and 12 College Place, New York.

BUSINESS DIRECTORY AND INDEX OF ADVERTISEMENTS.

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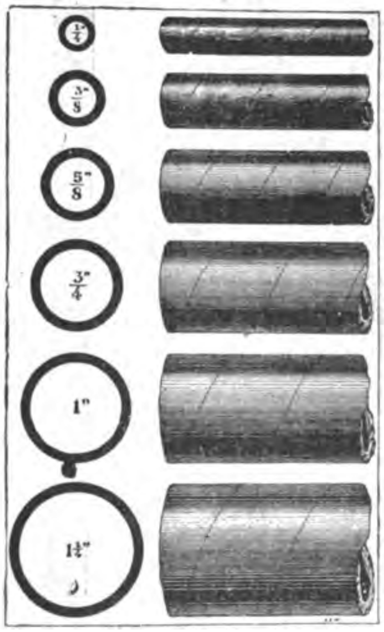


THE SOLUTION OF THE PROBLEM

—OF—

SAFE GUARDING ELECTRIC CONDUCTORS,

Wherever and for whatsoever purpose employed, is to be found in the

CONDUIT SYSTEM

Interior and Underground Conduits,

MANUFACTURED BY

The Interior Conduit & Insulation Co.

WORKS:

527 to 531 West 34th Street, 526 to 528 West 35th Street.

GENERAL OFFICES, 42 AND 44 BROAD ST., NEW YORK.

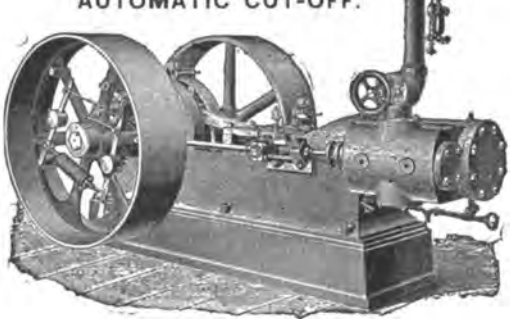
ELECTRICAL ENGINEERING Co., 320 Dearborn Street, Chicago, Ill.
SOUTHERN ELECTRIC Co., Baltimore, Md.
THOS. DAY & Co., 222 Sutter Street, San Francisco, Cal.
B. FRANK JOHNSON, Provident Building, Philadelphia, Pa.

N. Y. SAFETY STEAM POWER CO.

STEAM ENGINE BUILDERS AND CONTRACTORS.

DURABILITY

AUTOMATIC CUT-OFF.



ECONOMY

ELECTRIC LIGHT ENGINES.

VERTICAL, 2 TO 100 HORSE POWER.
HORIZONTAL, 20 TO 250 HORSE POWER.
VERTICAL AND HORIZONTAL TUBULAR BOILERS.

30 Cortlandt St., New York,
Also, 64 So. CANAL ST., CHICAGO.

HILL'S

Double Pole Converter

Switch.

Opens both poles of primary circuit, thereby avoiding all danger while working on the converter, or on the secondary circuit.

WARREN S. HILL,

133 Oliver St., Boston, Mass.

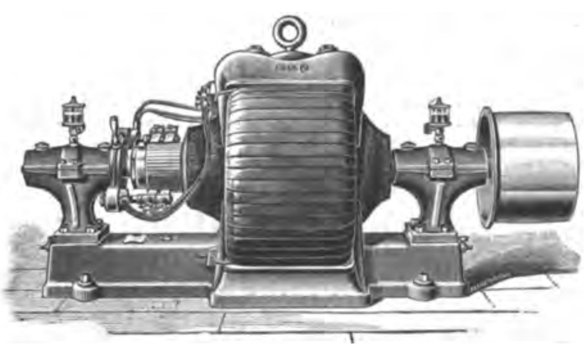
C. & C. Electric Motors and Dynamos.

Electric Motors in all standard sizes for operating Elevators, Pumps, Printing Presses, and machinery for general manufacturing purposes.

Electrical Mining Machinery of all kinds, Hoists, Tram-Cars, etc.

Electric Blowers for Ship Ventilation. Fan Outfits, Electric Plants for Pumping Church Organs.

Over 10,000 Motors in Actual Operation.



Dynamos in all sizes of same design and dimensions as the Standard Motors.

Equipment of Mines, Factories, Machine Shops, Office Buildings with complete Electrical Plants for Lighting and Power.

New England Office, 63 Oliver Street, Boston.
Philadelphia Office, 38 S. Fourth St.
Chicago Office, Phenix Building.
San Francisco Office, 35 Market St.

THE C. & C. ELECTRIC MOTOR CO., 402-404 Greenwich Street, New York.

THE

Electrical Engineer.

VOL. XII. AUGUST 5, 1891. No. 170.

THE FRANKFORT INTERNATIONAL ELECTRICAL EXHIBITION—IV.

BY

Richard O. Heinrich.

Building for Scientific Apparatus and Electro-Medicine.

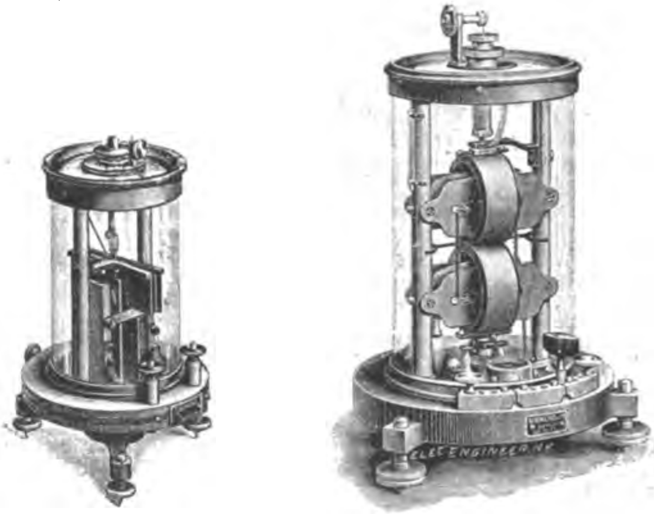
BY far the greater part of this building is occupied by Messrs. Siemens & Halske. This represents only a small part of the exhibit made by this firm in the different buildings, and it may almost be said that the exhibition is more or less monopolized by three large concerns, viz, Siemens & Halske, Schuckert, and Helios. The exhibit referred to represents a very complete testing and calibrating laboratory. It is interesting in its general design, and contains, besides the well-known types of instruments manufactured by this firm, quite a number of novelties of more than passing interest.

Five divisions are made, as follows: 1. Machine-testing room; 2. Cable-testing room; 3. Calibrating-room; 4. Laboratory for measurements of precision; 5. Workshop. A sixth addition is made at present in which it is the intention to show by means of vibrating flames and rapidly-rotating mirrors the vibrations made by the diaphragms of telephones, microphone transmitters, etc. The general idea followed throughout in this laboratory is to make the time required for technical tests a minimum by the employment of a bewildering multitude of switchboards and special arrangements. Some appear rather complicated and cumbersome, but all are of excellent workmanship.

The machines to be tested are placed on adjustable base-plates. A number of electric motors, of different capacities, are always in readiness to be belted to the machines under test. Time tests are made, and the E. M. F, current and resistance, hot and cold, of the dynamos are measured in an adjoining section. The instruments used for measurement are mainly the Siemens torsion galvanometer, Fig. 1, which is used as a voltmeter and ammeter; one instrument, with the necessary shunts and multiplying resistances, is used in the laboratory. The shunts and resistances are naturally of such dimensions that a multiplication of the scale divisions with a power of ten gives the respective values directly in volts and amperes; a switch enables the observer to take the two readings almost simultaneously with the same instrument. Resistances are tested with the Wheatstone bridge, or a modified Thomson bridge for very low resistances, and a sensitive mirror galvanometer.

As to the torsion galvanometer, apparently the standard instrument adopted in Germany, it may be said that the same measurements may be made with any very sensitive voltmeter, as, for instance, the Weston voltmeter, which is even decidedly preferable to the torsion galvanometer for a number of reasons. The torsion galvanometer has to be placed level on a rather solid foundation in a north-south direction. When a current is passing, the torsion-spring has to be adjusted until the pointer of the magnet returns to zero. The instrument is therefore, strictly speaking, not direct reading. It is true the resistances and the torsional force of the spring are chosen in such a way that each scale division corresponds to a whole or a simple fraction of a volt or ampere. The indications of the instrument are very much influenced by surrounding magnetic disturbances, or by a change of the magnetic movement of the bell magnet of the galvanometer itself. If such a change takes place the comparative direct reading can only be re-obtained by adjusting the torsional spring. There may also be a chance, even if very remote, of changing the torsional force of the spring by an overtwisting, or by giving a jerking motion to the magnet.

There is on exhibition an apparatus, or rather combination of apparatus, by which the torsion galvanometers are calibrated. It is the application of Poggendorff's method with some very practical modifications. The standard E. M. F. employed is a Clark cell. Temperature corrections are made directly with the adjustable rheostat, and checks,



FIGS. 1 AND 2.—SIEMENS TORSION GALVANOMETER AND ASTATIC ELECTRO-DYNAMOMETER.

if necessary, can be made with a silver voltameter. The whole combination of Clark cell, rheostats, and silver voltameter is mounted on one board, very handy for use. It is evident that the calibration of the instrument must be exceedingly correct (the possibility of reading off very inaccurately is not very great), since each instrument is said to be calibrated with the apparatus mentioned. The absolute constancy of the Clark cell, in inexperienced hands, may be a doubtful point, which, however, can easily be remedied or verified. The resistance of the instrument as a voltmeter is not nearly so high as, for instance, in the Weston instrument for the same ranges. To the American taste the instrument would appear flimsy and not very portable with all the shunts and series resistances.

Since this torsion galvanometer is not very well known in America, it may be well to be a little more explicit, Two types are manufactured, one with 1 ohm resistance in the galvanometer coils, the other with 100 ohms. If the instrument is to be used as a voltmeter, series resistances enclosed in a circular box give the different ranges of the instrument. With a 1 ohm galvanometer, for instance, there would go a resistance box, containing 9, 99, 999, and 9999 ohms. The following table would then represent all the necessary data about the instrument as a voltmeter.

Resistance of galvan. plus series resistance.	Sensitiveness.	Total range.
1 ohm.	1 on scale = 0.001 volt.	0 to 0.17 volts.
10 "	1 " = 0.01 "	0 to 1.70 "
100 "	1 " = 0.1 "	0 to 17. "
1,000 "	1 " = 1 "	0 to 170 "
10,000 "	1 " = 10 "	0 to 1,700 "

Using the instrument as an amperemeter, different shunts are necessary; usually $\frac{1}{9}$, $\frac{1}{99}$, $\frac{1}{999}$, $\frac{1}{9999}$ are furnished.

Shunt.	Total resist. of branch.	Sensitiveness.	Total range.
∞	1.	1 = 0.001 amp.	0.17 amp.
$\frac{1}{9}$	0.1	1 = 0.01 "	1.7 "
$\frac{1}{99}$	0.01	1 = 0.1 "	17 "
$\frac{1}{999}$	0.001	1 = 1 "	170 "
$\frac{1}{4999}$	0.0002	1 = 5 "	850 "
$\frac{1}{9999}$	0.0001	1 = 10 "	1,700 "

The resistance of the instrument as a voltmeter is rather low for the respective ranges in comparison with the Weston instruments, which have 80,000 to 100,000 ohms and more, for a range of 150 volts. The resistance as an ammeter is rather high. (Weston 15 amp. scale, 0.0022 ohm; 150 ampere scale, 0.00022 ohm.) In the first case the instrument will be subjected to heating errors, and also in the second an unequal heating of shunt and galvanometers will easily change the apparent ratio, since both are entirely separated, and if used with stronger currents, are not at all likely to have the same temperature.

The usual defense of our German confreres is that the instrument answers perfectly for all practical purposes! On the other hand it was seriously claimed in my presence that the Americans were not able to make instruments of precision. Suppose we cannot make them, then we have at least the common sense to appreciate a good and accurate instrument, and use it wherever necessary, regardless of price. An American central station manager of any conscience whatever appreciates the money-saving qualities of a voltmeter which is accurate within 0.15% under all circumstances, which is an impossibility with an instrument in which soft iron constitutes the moving parts. Ammeters of this type are excusable; but to make a general practice of using cheaply constructed voltmeters for incandescent light installations is certainly uneconomical and bad. If, as the makers, and often the users, claim, the magnetic lag, etc., in such instruments may be entirely neglected, they imply at the same time that a change in pressure of from 2 to 4%, and more, does not seriously affect the life of the lamps,—which remains to be proven.

In Fig. 2 is shown an instrument in which some of the weak points of the torsion galvanometer, and of the usual form of electro-dynamometer, are eliminated. It is an astatic electro-dynamometer. Two coils precisely equal in resistance and magnetic moment are united to an astatic couple and suspended by a fine silver wire. A torsional spring above and below controls the zero point, and the current is taken to the coils through very fine wire spirals, the torsion of which may be neglected. This astatic couple is movable about two stationary coils, as shown in the illustration; otherwise the instrument is identical with the usual form of electro-dynamometer. Instead of having a degree scale, and furnishing a table of the respective value, a scale giving divisions of the squares allows the reading to be made without computation. This instrument has the great advantage of being entirely uninfluenced by external magnetic changes. It is not very dead beat, and its sensitiveness is very small in the neighborhood of the zero point, as it is in all instruments in which the deflections are proportional to the square of the current.

THE PITTSFIELD, MASS., ELECTRIC LIGHT STATION.

BY

McSullivan.

THAT electrical progress has penetrated the poetic Berkshire Hills—the delightful strip of Western Massachusetts made famous by Hawthorne, Bryant, Fanny Kemble and others—and become firmly established, with all its improvements and conveniences, may not be known even to those whose names have become prominent in the electrical industry, and who at one time or another have claimed these charming hills as their home or resort.

Bountiful Nature seems to have poured out her richest treasures upon this favored section, and the introduction of electric light and power—those adjuncts now absolutely necessary to complete the list of appliances for comfort and convenience—leaves but little that could further enrich and render attractive its hills and valleys. Thus it is that the new central station at Pittsfield, Mass., is well worthy of attention. Situated in the heart of this largest town in

FIG. 1.—GENERATORS, PITTSFIELD, MASS., ELECTRIC LIGHT STATION.

the Berkshires, the station is in itself a model. It embraces features which are destined to be essential in the central station of the future, the principal one of which is its *composite* character.

Within walls of tasteful design are to be found the four divisions of the modern station, viz., incandescent and arc lighting, generators for supplying current for electric railways, and dynamos for furnishing electric energy to users for the various purposes to which electricity is now being adapted.

Electricity made its début in Pittsfield some six years ago in the shape of a single arc dynamo which was started to supply light to a few enterprising merchants who clubbed together for the purpose. From a small beginning this growing city has now realized a most perfect installation. The broadest streets are illuminated by arc lights, while the more shaded ones get their light from the little incandescent lamps connected in multiple series. To people visiting the town from the surrounding villages, notable among which is the far-famed Lenox, the perfect street lighting must be a revelation, as Pittsfield is one of the very few towns in the country which possesses this combined electric system for dispelling the gloom and darkness.

The station building is of a type known as "mill construction," and is considered fireproof. The term "mill construction," it may be said, defines a building in which the interior, or body of the building proper, is entirely independent of the side walls, thus minimizing the jarring

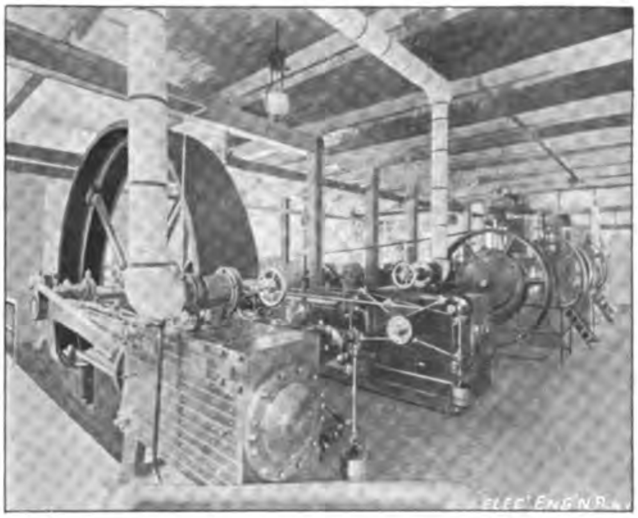


FIG. 2.—ENGINES, PITTSFIELD, MASS., ELECTRIC LIGHT STATION.

effect. It is a two-story building. The engines and dynamos are located on the first floor; the laboratory of Mr. Wm. Stanley, Jr., whose work in the alternating field is so well known, occupies the second.

There are now six Westinghouse alternating incandescent, two Thomson-Houston arc dynamos, and three Westinghouse constant potential, 500-volt, 50 h. p. generators. One of the latter is being used for the commercial power work, and the other two for supplying current to the street railway system. These are shown in our engraving, Fig. 1.

The motive power consists of one 400 h. p. Harris Corliss, and three Westinghouse engines of 100 h. p. each, shown in Fig. 2. The large Harris Corliss is used for the

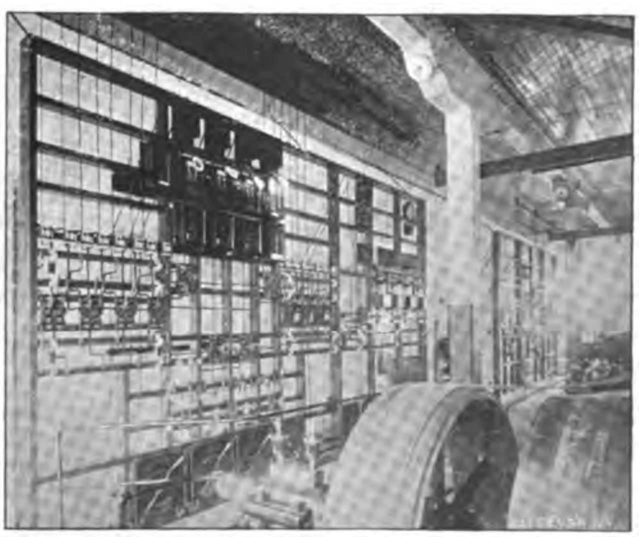


FIG. 3.—SWITCHBOARD, PITTSFIELD, MASS., ELECTRIC LIGHT STATION.

heavy work, while the smaller ones are reserved for light day duty. Power from the large engine is transmitted by a heavy belt to a shaft which extends along the west side of the building, on which are arranged tight and loose pulleys.

The switchboards, Fig. 3, occupy the entire north end of the room, directly in front of the offices. Between them and the wall is sufficient distance to allow of inspection from the rear without difficulty. The board is so divided that one side is for street and commercial incandescent lighting; the other half is devoted to arc light, motors and street railway power circuits.

Wires conduct the current from the generators to switchboard through tubing placed under the floor, and from there the wires to the outside circuits are led to a large pole a short distance from the station. Cross-arms on this pole are arranged in the form of a triangle, to which all the wires leading into the station are attached.

The laboratory of Mr. Stanley on the second floor is to be his future workshop. Here he has arranged one of the most complete laboratories to be found anywhere. It embraces a large chemical room, draughting department and workshop. The latter is a large, well-lighted room, and fitted up with all kinds of machinery for experimental purposes. Here it is that Mr. Stanley will carry on his work which has resulted in the past in so many valuable additions to the electrical industry.

The boiler-room, shown in Fig. 4, is a wing attached to the main building, 45 x 85 feet, at the end of which is the stack, 90 feet high, with 68-inch flue. The room contains

FIG. 4.—BOILERS, PITTSFIELD, MASS., ELECTRIC LIGHT STATION.

at present four boilers, built by Mr. H. S. Russell, of Pittsfield, having a capacity of over 700 h. p., and space has been reserved for additional ones for future demands.

The many advantages of the electric light are highly appreciated in Pittsfield, and its rapid introduction is surprising. As is well known, this beautiful old town contains some of the finest country residences in the Union. New ones are constantly being erected, and in nearly every case the new buildings have the electric light installed.

The electric street car system, lately inaugurated, will serve to emphasize the great superiority of this new form of propulsion. The village itself is greatly scattered. Embraced within its limits are several smaller hamlets devoted to manufacturing. From these outlying districts hundreds of people enter the village proper every night. Heretofore the horse cars have not been able to meet the requirements of rapid travel with heavy loads. Altogether Pittsfield is to be congratulated on its electrical facilities, and the success attained will no doubt lead other towns in that locality to follow its example. The road leads from the heart of the town to a pleasure resort called Pontoosac Lake, a distance of three miles.

CAPT. DE KHOTINSKY, whose name is well known in the field of electric lighting, will sail from Europe for this country in a few days, in the interest of the Germania Electric Co., of Boston, which controls his inventions here.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—X.

BY

Chas. Steinmetz.

VII. Self-Induction in the Secondary Circuit.

Until now, we have considered the secondary circuit of the transformer as closed by a non-inductive resistance, so that there is no self-induction present except the magnetic leakage of the transformer proper, treated of in chapter V. If the secondary circuit is closed by an inductive resistance, for instance an electromagnet, the secondary current lags behind the secondary E. M. F. by an angle δ. To determine this angle, we proceed in the following way :

Let s_1 = the magnetic resistance of that magnetic circuit, which causes the self-induction of the secondary current. This secondary current may flow around this magnetic circuit in m turns. Then the M. M. F. of the secondary current C_1, exerted upon the magnetic circuit of the magnetic resistance s is, $F_1' = m\ C_1$, and hence the magnetism produced thereby is $M_1 = \frac{m\,C_1}{s_1}$.

This magnetism induces the maximum counter E. M. F.,

$$\varepsilon_1 = 2\,\pi\,m\,N\,M_1 = \frac{2\,\pi\,m^2\,N\,C_1}{s_1}.$$

The E. M. F. consumed in overcoming the secondary electric resistance is $\varepsilon_1 = C_1\,r_1$. Therefore the secondary E. M. F., ε_0, impressed upon this inductive resistance s_1, is derived in Fig. 21 from the parallelogram of E. M. F.'s $o\ \varepsilon_1\ \varepsilon_1\ \varepsilon_0$, where the heating E. M. F., $\overline{o\ \varepsilon_1}$ is perpendicular to the induced E. M. F., $\overline{o\ \varepsilon_1}$, as $\overline{o\ \varepsilon_0}$, and gives the impressed secondary E. M. F.,

$$\varepsilon_0 = \sqrt{\varepsilon_1^2 + \varepsilon_1^2} = C_1\ \sqrt{r_1^2 + \left(\frac{2\ \pi\ m^2\ N}{s_1}\right)^2},$$ and the

angle of retardation, $\delta = \overline{\varepsilon_1\ o\ \varepsilon_0}$; hence, $\tan\ \delta = \frac{2\,\pi\,m^2\,N}{r_1\,s_1}$.

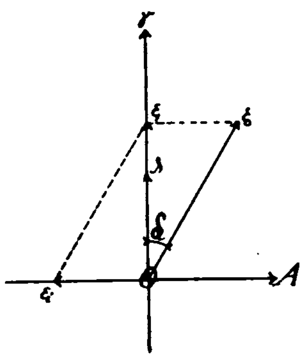


FIG. 21.

For producing the transformer diagram, in Fig. 22, we make as usual, $\overline{o\ F} = F$ the resulting M. M. F., $\overline{o\ E_1{}^1} = E_1$ the secondary E. M. F., produce a half circle with $\overline{o\ E_1{}^1}$ as a diameter, and make angle $E_1{}^2\ o\ E_1{}^1 = \delta$. Then $\overline{o\ E_1{}^2}$ is the resulting, or heating, secondary E. M. F.

Producing in the same way half circles over $\overline{o\ L_1{}^1}$ and $\overline{o\ C_1{}^1}$ as diameters, we get the secondary M. M. F., $L_1 = \overline{o\ L_1{}^2}$ and the secondary current, $C_1 = \overline{o\ C_1{}^2}$.

Completing the parallelogram of M. M. F.'s, with $\overline{o\ F}$ as a diagonal and $\overline{o\ L_1{}^2}$ as one side, $o\ L_1{}^2\ F\ L^2$, we get the primary M. M. F. as the other side, $L = \overline{o\ L^2}$, if we neglect the influence of hysteresis and eddies.

When taking into consideration hysteresis and eddies, by means of an ideal current, or rather ideal M. M. F., $\overline{o\ A}$, we have to produce this M. M. F. $\overline{o\ A}$ with the same phase as the secondary current $\overline{o\ C_1{}^2}$, and derive the point K, whence by the condition $\overline{F\ K} = \overline{o\ A}$ and $\overline{F\ K} \parallel \overline{o\ C_1}$.

This gives a somewhat different form of the curve of magnetic lag, k, as shown more particularly in the next chapter.

From the primary M. M. F., $L = \overline{o\ L^2}$, we get the primary current, $C = \overline{o\ C^2}$, and the primary heating E. M. F., $E = \overline{o\ E^2}$, and by the parallelogram of primary E. M. F.'s, $o\ E_1\ E^2\ E_0{}^2$ the primary impressed E. M. F., $E_0 = \overline{o\ E_0{}^2}$.

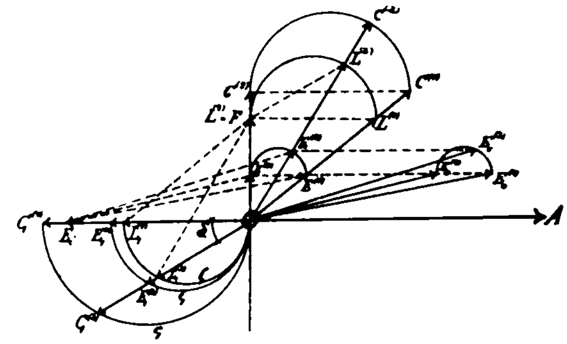


FIG. 22.

Now suppose the self-induction of the secondary circuit increases from 0 to ∞, then angle δ increases from 0 to 90°, and the secondary current, C_1, and the secondary M. M. F., L_1 travel on the half circles c_1 and l_1, from $C_1{}^1$, that is, $L_1{}^1$ to 0.

In the same manner L, C, E, E_0 travel on half circles, from $L^1, C^1, E^1, E_0{}^1$ to $L^2 = F$, that is, $C^2, E^2, E_0{}^2$, and we derive the following results :

If the self-induction of the secondary circuit increases, while the other constants remain the same, the phase of the primary current C increases, the phase of the primary impressed E. M. F., E_0 first increases, reaches a maximum, and then decreases again. Hence the difference of phase between primary current and impressed E. M. F. increases first slowly, then faster.

The difference of phase between primary current and secondary current, $C\ o\ C_1$, being almost 180°, increases very slowly, and reaches 180° for infinite self-induction. Any change of the phase of the secondary current therefore enforces a change of the phase of the primary current, so that both currents always have almost opposite phases.

Hence the transformer cannot be used for producing shifting of phases, but any self-induction or capacity, thrown into the secondary circuit, acts almost exactly in the same way upon the primary current, as when directly connected into the primary circuit, so that both currents always have very nearly opposite directions of equal phase.

ELECTRICITY AND ART.

MR. JAN VAN BEERS, in London, recently held a social gathering at the Continental Gallery to welcome his English patrons. Over a hundred guests sat down to supper, which in its way was unique. Astonishing effects were produced by the electric light. The supper table was made of glass, covered with an ordinary white table cloth ; underneath 300 incandescent lamps of various shades were placed, which suffused the table with light. Electric lamps were placed in every nook and corner of the room. The installation, which consisted of 575 lamps, was fitted up by Messrs. Mellier & Co., of Margaret street, Cavendish Square, under the superintendence of their engineer, Mr. W. Lowry. The whole of the work was completed by four men in one day.

THE SCHUCKERT TRANSFORMERS.[1]

After a series of studies undertaken to determine the most economical form to be given to converters, the firm of Schuckert & Co., of Nuremburg, Germany, have adopted the type illustrated in the accompanying engravings, Figs. 1 and 2. This will be seen to consist of a slotted ring, the coils being placed in radial slots, and the magnetic circuit completed by a ring-shaped cover which is bolted to the main core. Several advantages are claimed for this type of transformer. Thus, the coils may be wound in a lathe and insulation can be made perfect, and in case of accident to a coil it can be readily removed and a new one inserted. In order to obviate the jumping of a spark from primary to secondary, a sheet of copper is laid in between the two,

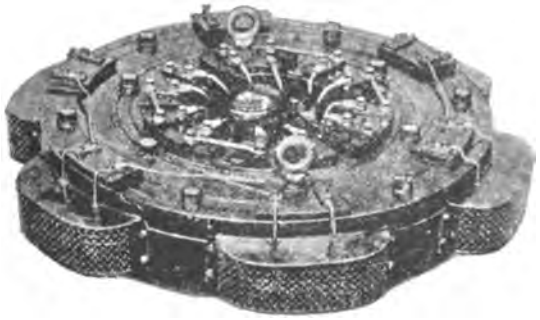


Fig. 1.—Schuckert Transformer.

and connected with the iron ring on one side, and the iron ring is permanently connected to earth, so that it can always be handled with impunity. The spark would therefore have to pass through the copper sheet first, and would reach the ground before entering the primary. The smallest number of slots which could be given to such a transformer is four; and in this case the complete ring represents two transformers entirely independent of each other. Larger rings built up of band iron are given a larger number of slots, as shown in the engraving, Fig. 2, in which

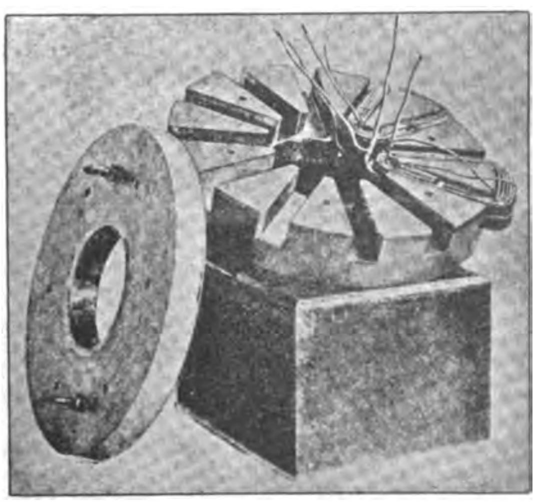


Fig. 2.—Schuckert Transformer.

the transformer has 12 slots, affording room for six individual and independent transformers, which can be coupled up in series or parallel in any desired manner. The flexibility of these larger transformers is thereby greatly increased, not only for laboratory work, but also for many practical purposes, where this subdivision presents many advantages. Thus the destruction of one coil would not by any means place the converter out of service. The peculiar construction of the transformer also makes it possible to obtain currents having any desired difference of phase; for example, taking the most simple case, that of a flat ring with four slots, as shown in Fig. 3. Here the primary windings are laid in slots 1 and 4, and 2 and 3, and the secondary windings, on the other hand, in slots 1 and 2, and 3 and 4. The secondary currents generated differ in

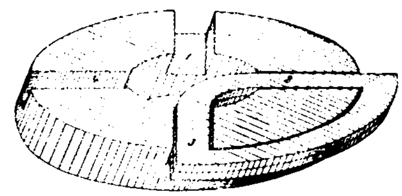


Fig. 3.—Schuckert Transformer.

phase 90° from each other, but differ only 45° with respect to the primary currents. These ring transformers are being exhibited by Messrs. Schuckert & Co. at the Frankfurt Electrical Exhibition, and are operated at 100 reversals per second.

1. *Elektrotechnische Zeitschrift.*

SWINGING BALL LIGHTNING ARRESTER.

BY

F. H. Tidman.

In the summer of 1888 we had a severe lightning storm in the town in which we were operating an electric light plant, the first stroke of which entered a prominent store lighted by incandescent lamps on the converter system, and discharged upon the gas chandeliers, burning several sockets, and badly scaring the occupants. After this display the proprietor ordered all electric light wires off his premises, and did the electric light business great harm by telling people that blue flames shot out all over his store, and condemning the electric light as unsafe and dangerous to life and property. A short time after came another storm which shut down the plant by burning out the armature and destroying a number of converters. We concluded that if this was to be repeated every summer, there was little chance of securing a dividend for the directors, and that our customers would fall off. At about the same time another plant was nearly burned down on account of a comb lightning arrester with hard rubber base setting fire to a wooden partition, the brass comb having become fused together by the arc following, and short-circuiting the dynamo, the fuses of which did not burn out. The only thing which saved the station was presence of mind on the part of the engineer, who took an axe, cut down the partition, smashed the offending lightning trap and extinguished the fire.

With these facts before us, and having purchased the best arresters on the market, and being informed by the various arrester makers that all we had to do was to put their arresters in our station, one on each pole of the dynamo, we anxiously awaited another storm, which came while I was in the station at mid-day, while there was no current on the line. I saw a discharge take place on the station arresters, which I thought was rather heavy, and several others followed in rapid succession; the dynamo switches were open, and we thought the lightning had been carried to earth without doing any damage, but when we started up several complaints came in that lights were not burning, and one customer said there was a report like a gun in the box on the front of his house, and that the lightning struck it, and requested that it be removed at once, as his wife and himself had heard that the lightning had actually entered a store, the wires emitting blue flames. It then occurred to us that the lightning arresters were at fault, as our arc system received the same treatment, but to a lesser extent, which we attributed to its badly insulated condition, it being a very old line, which we intended to renew. We then studied all the works on static electricity, and reported effects of lightning, and were the first to conclude that we not only wanted arresters in our station, but also on our line. Having decided this important point, we cast about for an arrester which could be placed on the poles, and which would not ground our lines, needed no attention, did not cost much money, and was always ready, no matter how frequently the discharges took place. This we could not find; so we decided to make elaborate experiments in order, if possible, to supply our want.

We had before us all conceivable methods of producing rapid motion in a conducting body in order to break the following arc, and tried their practical value on our lines. Amongst other methods the pith ball was tried, suspended by a chain over a proper grounding device, and the chain connected to an arc-light circuit of 2,000 volts and 10 amperes. The arrangement was then attached to a powerful static machine, which would give a 19-inch spark in the air, and upon passing a discharge from the machine at a distance of about 3 inches from the discharging plates, the ball was violently thrown into motion and the following arc broken instantly. The experiment led us to make a complete outfit of these arresters, which were placed in wooden boxes and attached to a regular incandescent electric light circuit, with the result that no further trouble from lightning has ensued upon that line. Experience and time taught us that wooden boxes and galvanized iron covers with poor insulation gave trouble on account of effects of the weather upon the wood, which split and let in the rain, grounding

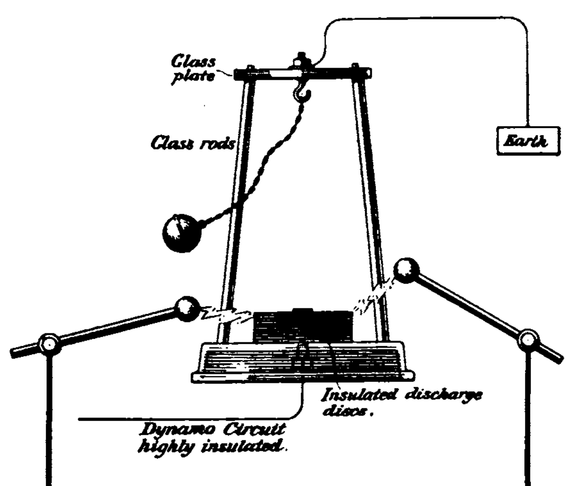


Fig. 1.—Swinging Ball Lightning Arrester.

the circuit; but we cared little for this, as they were evils which could be easily remedied by proper and careful construction. We then had the insulating material made of porcelain and the working parts covered by water- and dust-proof covers with brackets for attachment to poles, buildings, etc.

In order to enable those interested to repeat our experiment with the pith ball, I have made a sketch, Fig. 1, which explains itself to those who are familiar with the laws of static electricity.

We found that a metal ball would work in place of the pith ball, but that it must not be heavy or badly insulated from the opposite pole. It will be apparent to most of those who have to deal with heavy currents for light and power, that the following arc cannot exist under such circumstances. In practice it is found that the number of these arresters necessary to protect a mile of line with the average number of customers on a main street is 8, and it will be readily seen that a line provided with a number of discharging points, as shown in the accompanying illustration, Fig. 2, will never be troubled with broken lamps, converters, burnt-out motors, generators, etc., as the static charge from lightning is provided with points of lower resistance to ground than any part of the system.

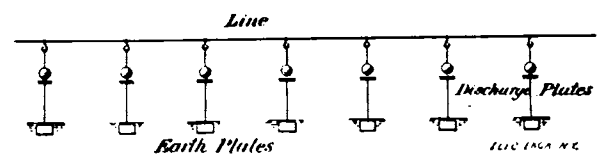


Fig. 2.—Swinging Ball Lightning Arrester.

Some persons ask, What would become of the arrester if the line were supplied with a current of 2,000 amperes and 500 volts? Our answer to such is, that the following current is instantly broken, and could not in any case burn out the arrester, even if the ball from any cause, such as careless installation, etc., failed to move, because the discharge plates, which are arranged as in the old-time telegraph and electric light arresters, would provide an insulation from a direct ground.

We may here state that the observed effect of a heavy and apparently direct stroke of lightning on an arc line was that the violence of the disruptive discharge was so great, that it blew the covers from the nearest arresters, leaving the swinging ball and discharge plate intact, and moving the ball in the arresters in the station to the same degree as in less severe strokes, and proved to the station operatives that they had nothing to fear from lightning of the most severe character.

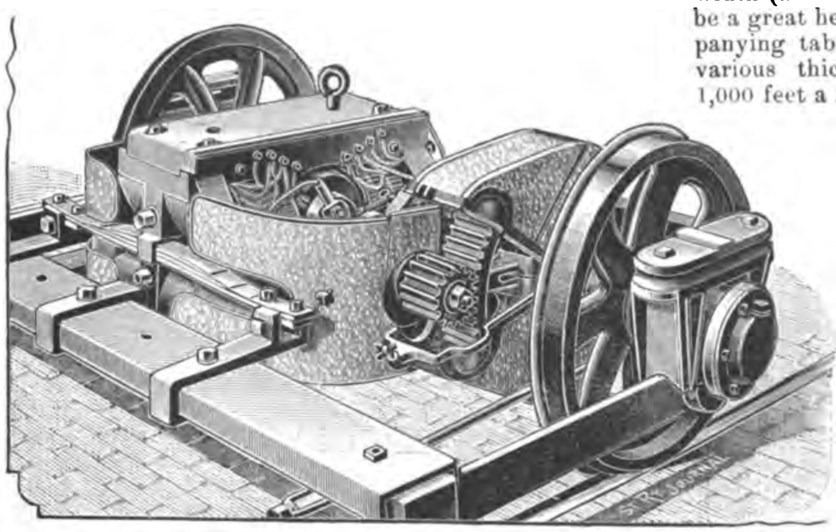
In conclusion, I would say that no station can afford to run without line arresters, which are the only safeguards against destruction to lamps, converters and motors; and further, that a single swinging ball arrester placed upon a large circuit is practically useless. It is, furthermore, against the laws of nature to expect lightning to carefully avoid lamps and motors and go gracefully to ground by the one arrester which we have heretofore provided at our stations.

THE FIVE-WIRE SYSTEM IN PARIS.

With the exception of the Vienna and Königsberg stations, the 45,000-light station, supplying the Place Clichy sector, which was recently inaugurated, is the only one of its kind in Europe. The Paris station has three floors, and covers a superficial area of 19,800 square feet. In the basement is the boiler plant, which comprises six of the Naeyer multitubular type. The ground floor is occupied by the steam piping, while on the first floor are placed the engines, dynamos and the distributing board. The generating plant comprises three 150 h. p. Armington and Sims engines, each belt driving two shunt-wound dynamos, and three 500 h. p. Corliss engines, running at 64 revolutions, and each of which is coupled direct to a 350-kilowatt (700 amperes at 500 volts) eight-pole machine The armatures of these dynamos are 11 feet in diameter, and the brushes bear on their exterior. A 250-cell battery of Laurent-Cely accumulators supplies current during the day. The district supplied by this station has an area of nearly two square miles, and the most distant feeding point is 2,750 yards away. To keep the pressure on the different branches at the proper value six sets of automatic apparatus are employed. The mains are all lead-covered, iron-armored Siemens cables. Aron meters are employed, and are modified to suit the exigencies of five-wire distribution, that is to say, the coils are arranged so that the current in the two outer leads exerts double the magnetizing influence of the current in the two adjacent leads, the central wire not passing through the meter at all. The Société Alsacienne de Constructions Mécaniques is responsible for the erection of the whole system.

THE WIGHTMAN ELECTRIC RAILWAY MOTOR.

In our issue of July 22 we described the improved electric car equipment now being manufactured by the Wightman Electric Manufacturing Co., of Scranton, Pa., and to



20 H. P. Wightman Motor Mounted on Truck.

the details already given we are now enabled to add the motor mounted upon the truck and the method of suspension. As will be seen in the accompanying engraving, the flexibility in suspension has been obtained by the use of a flat steel spring. The elasticity of this form of spring is greater than that of any other, and the tendency of the motor wires to crystallize and break on account of the jarring is reduced to a minimum.

The engraving also shows the Wightman Co.'s novel gear case. The construction is such that the gear can be exposed for examination at a moment's notice. The upper and lower halves of the case are hinged after the manner of a pair of shears. By loosening one bolt or thumbscrew the two halves swing one inside the other, in this way exposing the armature pinion, as shown. The pinion can then be removed without taking off the case.

The Wightman company have equipped a car with all their latest improvements, and fitted up as a drawing-room in the most exquisite taste. This car is intended to be taken about from place to place in order to demonstrate the value of the improvements introduced by the company.

ELECTRIC TRANSMISSION OF POWER AT FRIBOURG.

The municipal authorities of Fribourg are about to install a hydro-electric power transmission station at the Sarine dam, outside the town. The contract has been awarded to MM. Cuenod, Sautter & Cie., of Geneva, who will install two 150 h. p. 150 volt machines. Distribution will be effected on the three-wire system. The prices which it is proposed to charge are remarkably low when compared with the tariff elsewhere. Thus the charge for 1 h. p. during a year of 3,000 hours will be $69.00. In the case of a 5 h. p. motor, the charge will be $63.00 per h. p. per annum, and $39.00 per h. p. per annum for motors of 21 h. p. and upwards.

A HANDY RUBBER BELT TABLE.

BY

Every power user is confronted at some time with the problem of what belt width to get to drive his establishment, or certain machines therein, and very often his lack of proper information at first proves, after purchase, both annoying and expensive. To be able to pick out a belt width (and thickness) which will be just about right would be a great help; and such help is afforded by the accompanying table, which shows what width of rubber belt of various thicknesses is needed to transmit 10 h. p. at 1,000 feet a minute, with various arcs of contact on a cast-iron pulley. The belt joints are assumed to be made with single leather lacing. If other fastenings are used, there is a foot-note which enables due correction to be made. If the belt speed is double or treble that for which the table is made, only half or one-third the width will be required; and in like inverse proportion for other speeds. If the thickness for rubber belts offered for sale differs from those quoted, the widths required will be inversely proportional; thus, if the belt offered or contemplated be $\frac{7}{16}$ inch thick, there will be required a width between that demanded for $\frac{3}{8}$ and that for $\frac{1}{2}$ inch. Belt thicknesses are given in fractions of an inch instead of in "plies," because some makers' five-ply is not thicker than other makers' four, and some manufacturers make two or three thicknesses for each nominal number of plies. A few examples are here given:

1. It is required to know how many inches of belt $\frac{1}{4}$ inch thick (laced with single leather lacing) will be needed to carry 20 h. p. at 2,000 feet a minute, the arc of contact being 180°.

Table of Widths of Vulcanized Rubber Belts,

On Cast Iron Pulleys, with Various Arcs of Contact, to Carry Ten Horse-Power[1] at 1,000 Feet a Minute.[2]

(This table is for belts joined with single leather lacing [3])

Arc of contact.		Belt thickness in inches.				
		$\frac{3}{16}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$
30°	$\frac{1}{12}$ cir.	25.77	19.32	12.88	9.66	7.73
45°	$\frac{1}{8}$	18.20	13.65	9.10	6.82	5.46
60°	$\frac{1}{6}$	14.40	10.80	7.20	5.40	4.32
75°	$\frac{5}{24}$	12.18	9.13	6.09	4.06	3.65
90°	$\frac{1}{4}$	10.67	8.00	5.33	4.00	3.20
105°	$\frac{7}{24}$	9.70	1.27	4.85	3.64	2.91
120°	$\frac{1}{3}$	8 85	6.64	4.43	3.32	2 66
135°	$\frac{3}{8}$	8.30	6.22	4.16	3.11	2.49
150°	$\frac{5}{12}$	7.80	5.85	3.90	2.91	2.34
165°	$\frac{11}{24}$	7.46	5.60	3.73	2.80	2.24
180°	$\frac{1}{2}$	**7.15**	**5.36**	**3.57**	**2.68**	**2.15**
195	$\frac{13}{24}$	6.93	5.20	3.47	2.60	2.08
210	$\frac{7}{12}$	6.72	5.04	3.36	2.52	2.02
240	$\frac{2}{3}$	6.4	4.79	3.20	2.40	1.92
270	$\frac{3}{4}$	6.18	4.63	3.09	2.32	2.65
300	$\frac{5}{6}$	5.90	4.42	2.95	2.21	1.77

1. For other horse-powers, use proportionate widths.

2. For other thicknesses or for other speeds, inversely proportionate widths are needed.

3. For single rawhide lacing, multiply widths in the table by 0.928; for double leather lacings, by 0.867; for double rawhide, by 0.813; and for riveted joints, by 0.565; because, other things being equal, the stronger the fastenings, the more a belt of a given width will drive; and *vice versa*, the narrower need be the belt, for a given horse power.

The table gives for 10 h. p., at 1,000 feet a minute, 5.36 inches. To carry 20 h. p., at 2,000 feet would take the same, practically a $5\frac{1}{2}$-inch belt.

2. For a $\frac{5}{16}$ inch thickness there would be needed the average between widths needed for $\frac{1}{4}$ and for $\frac{3}{8}$, that is, $(5.36 \times 3.57) \div 2 = 8.93 \div 2 = 4.465$; or practically $4\frac{1}{2}$ inches.

3. For 20 horse at 1,500 feet, only $\frac{2}{3}$ as much width, or 3.57 inches; a $3\frac{1}{2}$-inch belt would do.

4. For double rawhide lacing, $5.36 \times 0.813 = 4.36$; or practically a $4\frac{1}{2}$-inch belt.

THE COMMERCIAL PRODUCTION OF HYDROGEN AND OXYGEN FROM THE ELECTROLYSIS OF WATER.[1]

Numerous attempts have in the past been made to reduce to a commercial scale the electrolytic generation of hydrogen and oxygen, but up to within quite recently these attempts have not met with success. It seems, however, that more recent experimenters have attained a sufficient measure of success to warrant the belief that this method has now arrived at a state of commercial practicability. The problem has been worked out simultaneously by M. Latchinof, of St. Petersburg, Dr. d'Arsonval, and Comdr. Renard of the French Army. The principles adopted are almost identical, but the apparatus designed by Comdr. Renard seems to be the most complete from the commercial standpoint, and was described in a paper recently read before the French Physical Society.

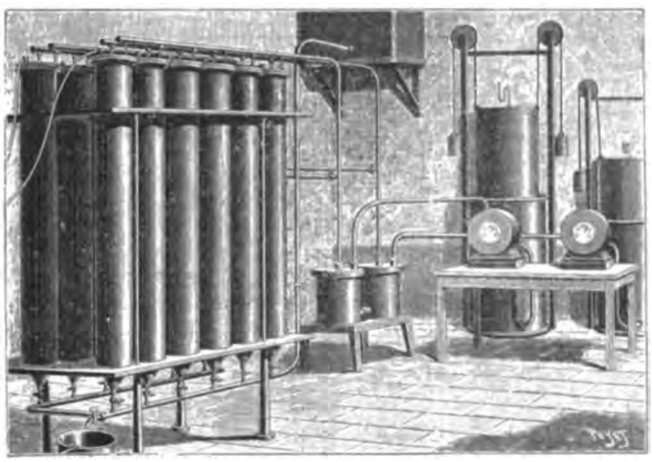


Fig. 1.—Commercial Manufacture of Oxygen and Hydrogen.

The new principles adopted in the construction of the large voltameters required are the following: First, the substitution of an alkaline solution instead of an acid, which makes it possible to employ electrodes of iron; second, the introduction of a porous partition between the electrodes, with the object of separating the gases. The experiments of Comdr. Renard have been made with a 15 per cent. solution of caustic soda, and a 27 per cent. solution of acidulated water; these are the proportions which give the maximum conductivity. Experiments made with the voltameter with platinum electrodes 3 to 4 centimetres apart have shown that for a given E. M. F. the alkaline solution allows a larger current to pass than the acidulated water; that is to say, it has a greater conductivity and is therefore more advantageous to use. The separating effect of the porous partition on the gases is due entirely to capillary phenomena. In order to prevent the gases from mixing through the partition above the level of the liquid, the partition must be made impervious above that line.

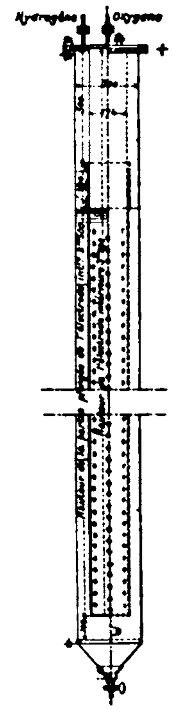


Fig. 2.—Commercial Voltameter.

The commercial apparatus employed by Comdr. Renard is illustrated in perspective in engraving Fig. 1, and Fig. 2 shows a section of one of the voltameters. The commercial voltameter consists of a large iron cylinder forming the outer electrode. The interior electrode is encased in a bag of asbestos cloth, closed at the bottom and attached by bands at the top. The inner electrode is pierced by holes, which allow the gases to ascend to the interior of the cylinder. The apparatus is hermetically sealed at its upper part, the two electrodes being, of course, insulated by a layer of rubber. Above the level of the liquid the interior electrode is continued and forms a receptacle for the gas. Hydrogen and oxygen escaping by the upper orifices are led to a compensator, which regulates the pressure within the tube. The apparatus is provided with cocks for filling with distilled water, which is placed in a reservoir above the voltameters, and for emptying. The size of the apparatus is as follows:

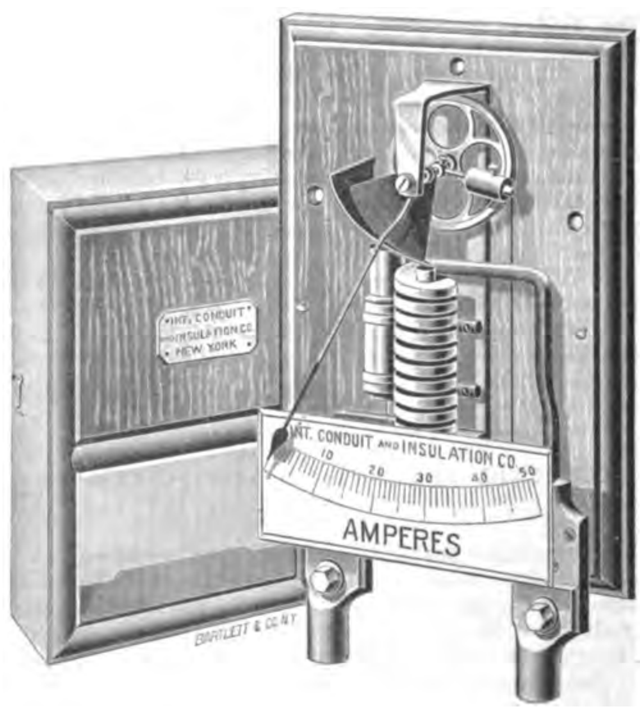
Height of exterior electrode,		11 ft. 4 in.	
" " interior	"	11 "	
Diameter of exterior	"		12 "
" " interior	"		7 "

The sheet iron employed is 2 millimetres thick. The electric resistance is about 0.0075 ohm. The current employed is 365 at 2.7 volts, and consequently takes a power of about one kilowatt. The production of hydrogen is equal to about 158 litres per hour.

1. Abstract from *La Nature*.

THE JOHNSON DEAD-BEAT AMPEREMETER.

The instrument illustrated in the accompanying engraving has recently been designed by Mr. E. H. Johnson for circuits in which very violent changes of current occur at frequent intervals, and where an instrument, other than one perfectly dead-beat would be of very little practical value. This amperemeter, as will be seen, consists of a soft iron



Johnson Dead-Beat Amperemeter.

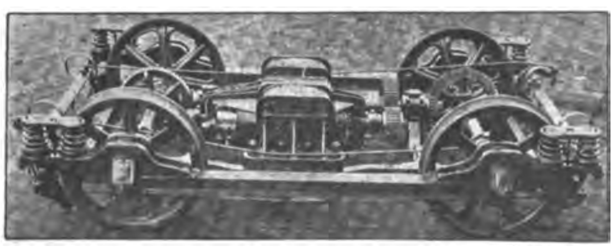
core wound with heavy bar copper, the magnet thus formed acting upon an armature having the shape of a sector, which is pivoted above the solenoid and provided with a pointer. The construction adopted for the armature is such that the scale divisions are practically uniform over the whole range of the scale.

This type of armature, while possessing in a marked degree the dead-beat quality, is, however, still further re-enforced in that respect by means of a dash-pot, shown in the engraving, the damping being effected by air-washing of the piston, no liquid being employed. The friction, therefore, becomes a practically constant quantity, and as the metal of the two interlocking pistons is never in actual contact, the delicacy necessary for accurate work is achieved.

The armature being under the influence of a strong electromagnet, is not influenced by currents in neighboring circuits. The resistance of the coil is also extremely low, that of the 25-ampere instrument measuring only .005 ohm. The qualities possessed by the instrument evidently make it peculiarly adapted for use in connection with motors and power stations, especially those devoted to railway work. This instrument, we may add, is now being brought out by the Interior Conduit and Insulation Company, of this city, and is designed for capacities varying from 10 to 200 amperes.

THE RAE STANDARD 40 H. P. RAILWAY MOTOR (TYPE B).

We have on several occasions described the successive improvements in the street railway apparatus of the Detroit Electrical Works, and are this week able to present to our readers an engraving of the new standard 40 h. p. railway motor designed by



Rae 40 H. P. Standard Railway Motor.

Mr. Frank B. Rae, the electrician and engineer of the company. One of the rules adopted at the outset by Mr. Rae was that an electric truck should have not more than one motor, which should be powerful enough to do all the work required of it, and the 40 h. p. motor truck illustrated is the outcome of this resolution. As will be seen, the motor gears directly with a shaft which runs lengthwise of the truck and is joined by beveled gears directly to the axle. These gears are accurately cut in special machines and have proved to be of excellent wearing qualities. The truck frame, it will be noted, is also of very solid construction, the entire truck forming one rigid frame, which keeps the motor and axles in proper position and avoids all wear due to jar and grinding.

KIND WORDS FOR "THE ELECTRICAL ENGINEER."

Mr. O. S. Platt, of Bridgeport, manufacturer of the "New England Electric Switch," writes us, under date of July 15, as to the result of his advertising in The Electrical Engineer: "Have received orders from all parts of the world, including all of the United States, the Southern Islands, Canada, England, France, Russia and Finland." * * * * "Have also found the efforts of your representatives to make me personally acquainted with those using goods in my line of great value, both socially and commercially, and am glad to acknowledge these courtesies."

Mr. H. A. Cleverly, the proprietor of the Cleverly Electrical Works, of 1018 Chestnut street, Philadelphia, has had a long and varied experience in the electrical field, and the fact that he has kindly sent us the subjoined will speak for itself: "Thanks for copy of Extra "Edison Lamp Decision." Its prompt issue and receipt are another evidence to the enterprise and push of The Electrical Engineer. It is the most valuable of the electrical journals. It is the only one I keep for future reference and am happy to say that I have every copy since its birth as the "Electrician," as well as under the present title. I wish you success and its full reward."

THE MILLER ELECTRIC RAILWAY CONDUIT.

A new departure in the arrangement of the several essential parts of an underground conduit system is that recently devised by Mr. John J. Miller, of Pittsburgh, Pa., and clearly shown in the accompanying illustrations.

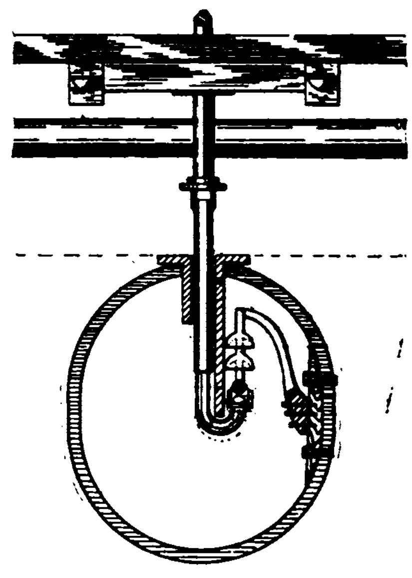


Fig. 1.—Transverse Section of Conduit, Miller System.

Here Fig. 1 represents a sectional and Fig. 2 a longitudinal view of the conduit. This is provided with slot rails, between which the trolley arm passes. The rail at the right, it will be noticed, extends below the wire, and protects it from any moisture that may find its way through the slot. The wire is suspended from a bracket, as shown, by means of a hard rubbber hanger. The trolley arm is provided at its lower end with a U-shaped extension, upon which is mounted the trolley. This prevents the moisture which may run down the rod from reaching the wheel.

It will be seen that the wire is suspended above all accumulations of water and rubbish in the conduit, and is protected from drippings by the double bell-hanger. Furthermore, the wire is doubly insulated from the conduit by means of the block and hanger, and there can therefore be no appreciable deflection of the current through the supports. The highest point of the bracket is at the point of its connection with the hanger, and therefore the bracket drains toward the side of the conduit and the hanger drains from the edges of its bells, thus preventing the wire from being connected with the side of the conduit by a film of water, and the wire is protected from an accumulation of moisture on its surface; the trolley is carried above the reach of water in the bottom of the conduit, and therefore there is nothing to interfere with a perfect contact between the trolley and the wire.

The Pittsburgh Underground Electric Construction Co. has been organized, with a capital stock of $300,000, for the purpose of

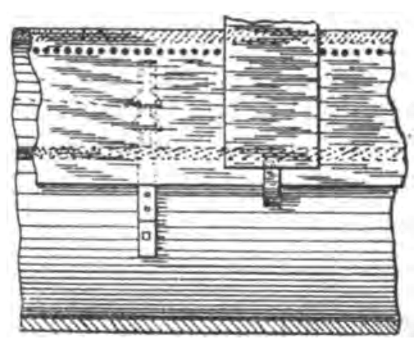


Fig. 2.—Longitudinal Section of Conduit, Miller System.

installing this system. The officers are Mr. C. D. Robbins, president, and Mr. D. J. Rex, secretary and treasurer. Mr. C. F. Shoemaker, Mr. F. A. Mann, of Cleveland, O.; Mr. F. J. Osterling, and Mr. John J. Miller, of the Robbins Electric Co., the inventor of this system, comprise the directory.

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Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers*

VOL. XII. NEW YORK, AUGUST 5, 1891. No. 170.

It is a great thing to find out what cannot be done; it leads up to a knowledge of what can be done.—James Watt.

PREPARING FOR THE WORLD'S FAIR.

THE article from our Western representative, Mr. W. F. Collins, appearing in the present issue, gives an interesting account of the progress made in the preparations for the Columbian Exposition at Chicago. Some fears have been expressed as to whether Chicago will have everything in readiness by the appointed time in 1893. For ourselves we may say that we have no fears at all on that score, and the explicit statements made by Mr. Collins will go far to remove doubts that may be elsewhere entertained on the subject. It has been assumed by not a few people in the East that, to use a homely phrase, Chicago had bitten off more than it could chew. Nothing could be remoter from the truth. While we believe that it would have been well to hold the Exposition in New York, we believe also that Chicago offers many special advantages and inducements, and that what would otherwise be lacking will be compensated for by the courage and large spirit of the city which, even more than Boston or Philadelphia, is typically American. Chicago has not over-reached itself, and though some of its citizens may attempt to do foolish and vulgar things as if to prove that 400 years have not passed since Columbus made the first exhibition of American products, we all know that as a whole the Fair will make us proud of the enterprise and intelligence of the metropolis of the West.

But there is still much to be done, and it must not all be left to Chicago to do. Electrical manufacturers and electrical engineers are peculiarly concerned with this coming opportunity, and their great attempt should be to make every visitor carry away as the chief impression the idea that the Exposition signalizes more than anything else the triumphs of electricity in the arts and sciences. Not only must there be exhibits on a large scale, but the utilization of electricity for light and power should be sought in every possible manner. Moreover, the Exposition should be made the scene of an Electrical Congress as large and important as that of Paris in 1889. The American Institute of Electrical Engineers has, in fact, already laid the foundation for such a Congress, and it seems high time that steps should be taken to give form and life to the plan. The last Electrical Congress held in America was that at Philadelphia in 1884. Since that time an enormous development has taken place, and Chicago in 1893 should be made the next point of departure in electrical investigation and industry.

BIDDING FOR CONTRACTS.

WRITING in the London *Electrical Engineer*, Mr. Sydney F. Walker takes up the question of the abuses which have arisen from the practice of submitting tenders or bids for electrical work in England, and, considering the frequent expense to which firms are subjected in preparing these bids and specifications, pleads that they ought to be paid for by the firms asking for them. To overcome this difficulty Mr. Walker argues that all bids or tenders involving much expense should be charged for, the charge to be deducted from the amount of the contract by the successful competitor. We have adverted to this subject in order to point out the difference which exists in the practice in this respect here and abroad. To apply this rule here would, we think, be hardly practicable. The trouble which Mr. Walker complains of is, we believe, largely due to two causes: First, to the fact that in England, especially, any one who contemplates the installation of electrical work of any magnitude calls in a consulting engineer. The latter draws up plans and specifications to no special standard, working out each detail of the equipment to suit his own ideas on the subject, and then asks for bids on these plans. Secondly, it rarely happens, abroad, that a single firm is in a position to offer a bid on all the apparatus required for the equipment of an electrical plant. In both these respects our practice is diametrically opposite. With us it is a rare occurrence that a consulting engineer is employed, the intending purchaser applying directly to the companies to furnish him with apparatus to perform certain work. Then, also, our companies furnish everything, down to the smallest snap-switch required in an installation. It will therefore be seen, that the number of firms likely to enter into the competition for a piece of work is at once limited. On the other hand, the firms bidding have a standard system of apparatus throughout, and hence are not required to go into the minute details and calculations of cost, as would be the case where the apparatus required has been designed by an independent consulting engineer often with peculiar ideas of his own as to the best methods to be employed. To the latter cause, we believe, most of the trouble complained of abroad is due.

Which of the two methods of procedure is calculated to give the best results is a question quite open to argument. The value of a good consulting electrical engineer is undeniable in any project involving the expenditure of considerable sums of money, and we might even go so far as to say that a more general recognition of this fact would have prevented much loss and inconvenience in the past in many of our electrical establishments—loss from which many indeed are still suffering. On the other hand, however, we hardly believe it to be the province of the consulting engineer to act in the role of a designing engineer, an error into which he is frequently apt to fall. With the variety of apparatus now manufactured by different firms it ought not to be difficult to select, as it were, from stock such apparatus as will fill the requirements of any particular case, and we believe that this method of procedure will prove eventually to be the most economical both for the bidder and the consumer. There will still be plenty of work for the consulting engineer.

LIGHTNING PROTECTION FOR ELECTRIC CIRCUITS.

The troubles and diseases to which dynamo-electric machinery are subject, even in the best-regulated electric light stations, are of such a nature that ordinarily the remedy to be applied is a simple one; and the apparatus being under constant supervision, interruptions from causes which may be determined locally can be readily taken care of. But there is one frequent origin of trouble, which, in spite of its recognition at the outset, may be said to be still one of the principal sources of annoyance and loss in central stations. We refer to the effect of lightning strokes, which coming in on the line, enter the station, and, failing to be diverted to earth, ruin the dynamos. On the other hand, the frequent damage to lamps and converters connected to the outside circuits proves conclusively that the arguments brought forward by Mr. F. H. Tidnam in this issue are correct. It would indeed appear strange that the lightning charge should follow the line directly to the station which is protected against such charges and entirely ignore all the apparatus and the far greater number of paths open to it between the point where the line is struck and the lightning arrester at the station. Mr. Tidnam therefore argues that for thorough protection against damage by lightning, not only the station, but the line itself, should be provided at frequent intervals with lightning arresters. His experience and opinion will no doubt be that of many other station managers, and we are glad therefore to give space to an article which may result in the more thorough protection of all electric apparatus connected to overhead circuits.

Putting in Wires and Fixtures.

Trouble has recently arisen in one of the New England towns because the local electric light company that had hitherto put in wires and fixtures itself, at about cost, had decided to give up that branch of the business and restrict itself to the outside work. All inside work was hereafter to be done by concerns making a specialty of that class of work and approved of by the company. There are one or two sides to this question, as every local company knows. It should not be the business of an electric light company to put in wires and fixtures any more than it has been for a gas company to put in pipe and fixtures, yet many have assumed the responsibility and have often been very liberal in order to get custom. Somehow such generosity seems to carry a punishment with it, and, as in the present instance, a change of plan has been necessary. But the practice of leaving the work to outsiders also has its drawbacks, one of which is that bad wiring and poor fixtures bring curses on the light and on the head of the innocent company that wants only to supply the current. Much the same question arises as to motors. Shall a local company handle the motors itself, or shall it allow anybody to loop in any motors, or as many, as he chooses? One of the prime conditions of prosperous existence is that a company shall maintain the integrity of its circuits, but to do this it must have a pretty thorough control of all the work done by outside concerns that in any way affects those circuits.

Industrial Condensers.

The important position which the condenser is destined to occupy in the electrical distribution of the future makes the results of researches on the best methods of construction eminently timely. Recent work in this direction by M. Maurice Leblanc seems to prove that the action of alternating currents on condensers is actually to improve their qualities. But he also draws attention to the care required in their construction. Mr. Tesla has also referred in his recent lecture to a number of points which must be observed in order to prevent the destruction of the dielectric medium employed in alternating current work at high frequencies, one of the principal precautions to be taken being the thorough expulsion of all air, a point which is also indirectly hinted at by M. Leblanc.

A New German Transformer.

Although at first slow to adopt the alternating system, German electricians are now thoroughly convinced of its wide application, and have taken up its introduction with an energy characteristic of the faith with which they are imbued. The latest type of German transformer, which we describe on another page, embodies a construction which, though not entirely new, possesses a number of novel features which give it certain advantages. Principal among these will probably be the facility offered for obtaining difference of phase between the currents generated, which, for the purpose of electric power transmission with the alternating motor, will prove to be a valuable feature.

The Montreal Convention.

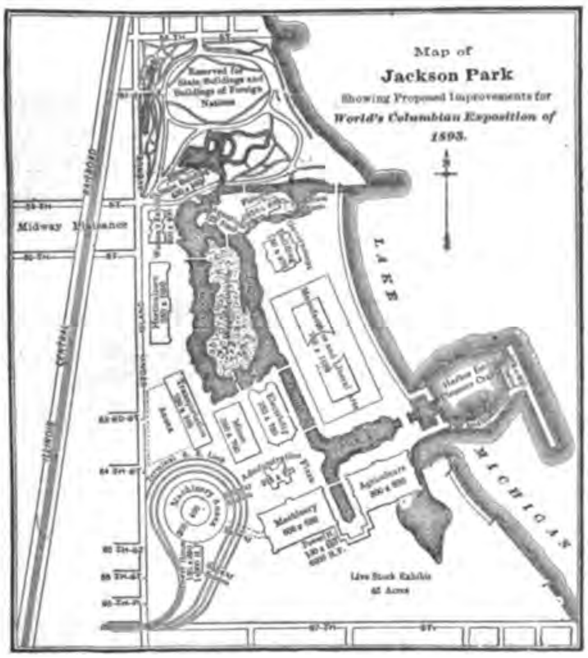
There is every indication now that the meeting of the National Electric Light Association at Montreal will be a great success, and it seems likely also that the exhibition will be one of the best yet given under the auspices of that body. It has been proposed to carry on the exhibition for several days and to charge gate-money, say 25 cents per head, the Association to take the first yield, but we trust that this scheme will be radically modified. The Association must stand distinctly aloof from all "hippodrome" business, and preserve its dignity and self-respect.

A VISIT TO THE WORLD'S FAIR GROUNDS.

BY

To any one in the electrical field or out of it who still remains at all sceptical as to the importance, size and scope of the Exposition in Chicago in 1893, a visit to the Fair Grounds will immediately be useful in dissipating any such ideas. He will be strongly impressed with the immensity of the arrangements made for the Exhibition and the remarkably rapid and thorough manner in which the work is now being pushed forward. The above remarks apply very pertinently to the electrical portion of the Exposition, and it may even now be said that this department will form one of the most important features, as electricity is to be used everywhere for all kinds of purposes in addition to furnishing illumination and motive power, in which operations it is already so well known in general every-day use.

One of the latest schemes for a striking display, but which appears somewhat impracticable at first sight by reason of the expenditure for construction and maintenance, and the difficulties inherent to such an undertaking, is the long-distance transmission of electrical energy from a power station situated at Niagara Falls and operated by that world-famed water-power. It might perhaps be carried out by the judicious use of transformers to



MAP OF THE WORLD'S FAIR GROUNDS.

raise and lower the electromotive force as required, although the thought of the valuable watts of electrical energy lost in the transmission over 500 miles of conductor is disheartening. Some of the would-be geniuses along the line might also take it into their fertile brains to tap the lines if they had the hardihood to dally with a probable 30,000 or 40,000 volt current. It may be in point here to suggest that it might be an excellent scheme to have all the condemned criminals electrocuted by the self-same current here in Chicago during the fair as a kind of side-show of morbid and thrilling interest.

Yet another "fad" is an electric firework display proposed by a French firm, and which has been submitted to the committee on ceremonies. Among the pieces proposed is The City of Chicago personified as a statue of fire, seated, and surrounded by figures of the States of the American Union. She will receive the great powers of the world, which will defile one by one before the assemblage of States. As each figure passes before the City of Chicago, it will halt, bow and then lay down its flag or shield at Chicago's feet and receive a palm branch of peace. This picture will form a grand firework, every point of which it is composed being of white or colored fire, and the successive appearance of the allegorical figures will be in multi-colored moving fire, presenting a marvelous kaleidoscopic appearance. The display together with numerous other pieces forming a background will present an illuminated surface of 21,000 square feet. The power necessary is estimated at 2,800 h. p., or $\frac{1}{10}$ of that if storage batteries are employed, and the effects are to be obtained presumably with incandescent lamps with perhaps some arc lamps; and probably the ever-willing motor will come in somewhere to operate the moving portions.

The contracts have been awarded, and actual work has commenced, on five of the buildings, namely, in the order stated, the Women's Building, the Electricity Building, the Transportation Building, the Mines and Mining Building, and the Horticultural Building. More will be started as soon as possible, and material is already on the way for the Administration Building and the Building for Manufactures and Liberal Arts.

A general plan view of the grounds in Jackson Park and the proposed improvements is shown in our illustration, the dimensions of the buildings being given, while the exact location of any one can be immediately determined.

The portion of the park where the fair is to be held has the appearance of a highly active battlefield. Men, material, freight-cars, railroad tracks, locomotives, dredges, and last, but by no means least, a whole army of kickers in the shape of the much-maligned mule, which having sold out of the street car business to go into landscape gardening, are to be seen on all sides, all busily working to the same end. To the uninitiated onlooker everything is in hopeless confusion, and he wonders how it is ever going to be all straightened out. But it will be.

More than 1,800 men are already at work, and this number is being rapidly augmented as the material arrives and new buildings are started. Over the construction tracks the engines are hauling material by carload after carload to the various buildings. The cheery hum of the saw-mill is also heard on all sides, those at present in operation being temporarily run by nondescript steam engines, which, however, will give place ere long to electric motors.

McArthur Bros., the contractors for all the grading and dredging, have six enormous dredges going merrily, completing the lagoons and lakes, which will form a veritable Venice of the grounds, and piling up the earth for hills and terraces, specially pleasing to the eye of the prairie-dweller.

The Woman's Building, in the northwest corner of the grounds, is well under way; the foundation timbers are in place, and the materials for the walls are on hand. This was the first building started, showing the energy and interest evinced by the women of the country.

The Electricity Building is situated at the south end of the lagoon, and is destined to be one of the handsomest of the buildings, as it undoubtedly will be the most attractive and marvelous to the sight-seer when the exhibits are all installed. The foundations are laid, the necessary material is on hand, and everything is progressing rapidly.

The grading for the Horticultural Building is completed. This Building will occupy the site just north of the temporary Administration Building, which is now being used as construction headquarters, and where the superintendents of departments, engineers and draughtsmen are busily engaged supervising and carrying out the work and making the various detailed plans. In the electrical part of the construction department the illumination details and the location of motors, etc., are being worked out. Work on the Mines and Mining Building is also progressing well, and here will be seen many interesting and practical exhibits of the adoption of electricity to mining of all kinds.

An immense amount of work has already been done on the lagoons, piers, and breakwater, the dredges running night and day cutting out the canal and connecting lakes; and a couple of steam pile-drivers are driving piles for piers and steamboat landings.

On the wooded island in the centre of the lagoon, at its south end, a temporary power-house for the generation of electric current, will be immediately built, and, in fact, work has already commenced. The plant will be in operation in five or six weeks. The station is laid out for an ultimate capacity of 600 h. p., of which 200 h. p. will be put in at once. This power will be employed for running dynamos for operating the arc lamps required for illumination of the grounds during construction, and also a large number of electric motors, which will be employed entirely for furnishing all the power for driving the various machinery, saw-mills, etc., used in constructing the buildings and performing any other work for which power is required. Incandescent lighting will also be run from this station wherever required.

The grounds are now intersected with railroad tracks in all directions, and a temporary pipe line for water supply has been laid. In every part the work is going on as expeditiously as possible, and no pains are being spared to have everything arranged in the best and most practical manner. The landscape architects are also exercising infinite care to beautify the grounds, which, when completed, will present a most artistic aspect, and, together with the magnificent buildings, will form a scene of unparalleled beauty and attractiveness on a scale unexcelled by any exhibition held in any country.

The thanks of the writer are due to Mr. Sargent, the electrical engineer of the construction department, under whose energetic supervision all the electrical construction and installation of plant are being carried out, for many particulars, and also to Mr. Geraldine, superintendent of the construction, for his courtesy in furnishing information.

THE GODFROY APPARATUS FOR INCREASING THE EFFICIENCY OF SUBTERRANEAN TELEGRAPH LINES.[1]

THE extensive development in France and Germany of subterranean telegraph lines has resulted in a demand for a device to render such lines as efficient as those carried overhead. To satisfy

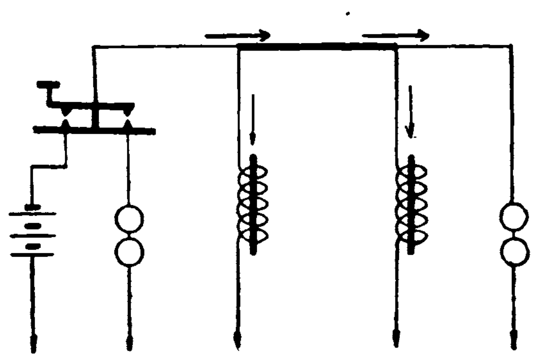


FIG. 1.

this demand, M. Godfroy has devised the arrangement shown in Fig. 1 of the accompanying illustrations, and first tested in the latter part of 1888.

The diagram, Fig. 1 (from an article by M. H. Cailleret, in the last number of the *Annales Télégraphiques*), shows an underground circuit arranged according to M. Godfroy's simple plan. When the transmitting key is depressed the electromagnetic shunt offers a considerable impedance, and the line is quickly charged. When the key is released, and during the instant when it is neither touching the front nor the back stop, the discharge current (now aided by the E. M. F. of self induction) goes quickly to earth through the shunt. Similar effects occur at the receiving end, and the net result is sharp, well-defined, Morse signaling. In 1888, the Paris-Angoulême line, 310 miles long, having a resistance of 5,000 ohms, and a capacity of 100 microfarads, was fitted with M. Godfroy's device. An ordinary Morse instrument, without either local or intermediate relays, attained a speed of 20 words a minute. The shunt circuit, which comprised an electromagnet with a closed magnetic circuit and a small auxiliary coil, had a resistance of 780 ohms and a coefficient of self-induction of 12 henrys. The battery consisted of 50 Callaud cells. The 1888 experiments showed that, in practice, it was not absolutely necessary to ensure a perfect balancing of the inverse effects of the capacity of the line and the inductance of the shunt. Thus one electromagnet gave equally good results on lines of from 150 to 200 miles in length, and another could be used on lines varying in length from 250 to 450 miles. It was only necessary to employ a battery suitable to the line, and either to adjust the resistance of the auxiliary coil, or to break the magnetic circuit of the electromagnet more or less thoroughly by altering the positions of the soft iron armatures.

Besides the French and German experiments some were carried out on an artificial line by Dr. Tobler at the Zürich Polytechnic.

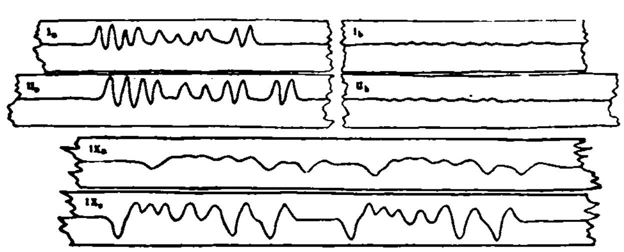


FIG. 2.

A syphon recorder was placed side by side with the receiver at the transmitting end, and registered the discharge currents from the line curves I*b* and II*b*, and curves I*a* and II*a*, Fig. 2, respectively, give an idea of the discharge currents at the transmitting end with and without the Godfroy electromagnetic shunt. The effect at the receiving end is shown in curves IX*a* and IX*b*. Curve IX*a* shows the signals received when the receiver was shunted by a resistance of 700 ohms. On replacing this inert resistance by one having considerable inductance, the curve IX*b* was obtained.

In France, some 20 long subterranean circuits, such as the Paris-Lyons (300 miles), Paris-Marseilles (650 miles) lines, have had Godfroy apparatus in regular work for the past 12 months and more; and recently it was decided to apply the device to 50 additional lines of over 125 miles in length. The apparatus is made in three sizes, having resistances of respectively 500, 750, and 1,000 ohms, and coefficients of self-induction of from 10 to 120 henrys.

1. London *Electrician*.

THE CONSTRUCTION AND PROPERTIES OF INDUSTRIAL CONDENSERS.[1]

THE development of the applications of alternating currents naturally draws the attention to the important subject of condensers, in which connection a brief account of the researches of M. Maurice Leblanc cannot fail to be of interest.

His first condensers were made of paper impregnated with paraffine heated to 70° C. These had a capacity corresponding to a specific inductive power equal to eight, but the residual charge amounted to nearly a quarter of the first discharge.

The capacity of the same condensers, when measured by the alternating current method, with a frequency of 75 periods per second, indicated a specific inductive power equal to one-third only of the above. On subjecting these condensers to a difference of potential alternating from 1,500 to 2,000 volts, with the same frequency, the heating produced was sufficient to melt the paraffine, to make the condenser hum, and to destroy it if the current were not quickly interrupted. With paper and paraffine specially selected for the purpose these results were not improved. By assimilating the paraffine with Poisson's dielectric, *i. e.*, a dielectric covered with conducting spheres, M. Maurice Leblanc found out the causes of the heating of the condenser, and of its great increase of specific inductive power, and discovered that by pre-

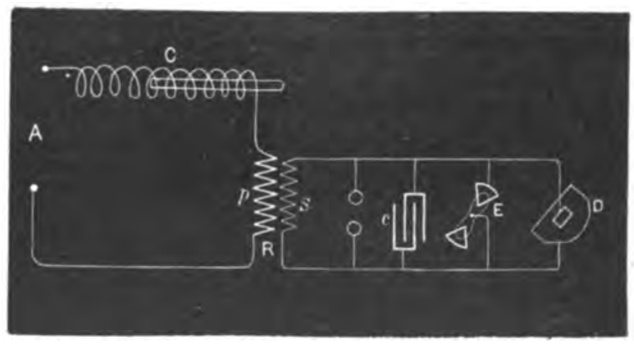


DIAGRAM OF EXPERIMENTAL CONDENSER.

A, Alternator; C, Choking coil; R, Ruhmkorff coil; *c*, Condenser; E, Electrometer; D, Dielectric tested.

viously heating the paper in the paraffine to the temperature of dissociation of the latter, the organic constitution of the paper is destroyed, and its fibrous structure entirely disappears. Condensers made in this way do not readily heat, and the specific inductive power falls to 2.56.

While these condensers were being made M. Leblanc made several experiments with the first ones, which, as he considered them defective, he used unsparingly, often subjecting them to differences of potential of 4,000 volts.

Having occasion later on to measure the capacity of some of them, he was surprised to find it much less than had been anticipated. The specific inductive power of the dielectric had become equal to 2.56. He examined them then to see whether the heating had not also decreased, and found that this was the case, as he had expected. These condensers, so faulty at first, no longer became heated, and had turned out excellent.

From the above it follows that excellent results may be obtained from paraffined paper; that we need not trouble about the quality of the material if we subject the condensers to a period of probation under the conditions indicated. They must be watched attentively while being used, and allowed to rest when they become heated to any extent.

This is a practical rule which is very easy to follow: A condenser runs no risk as long as it works noiselessly; when it begins to hum it is in danger.

It can easily be understood that what the action of heat had effected in a few hours (three on an average) would be brought about eventually by the electrical displacement produced in the centre of all the conducting particles contained in the mass. This is a fresh proof of that property of alternating currents which is now generally admitted, viz., that their action on dielectrics is beneficial rather than otherwise.

The ebonite condensers gave complete satisfaction. Their capacities, whether measured by the ordinary method or by the

1. London *Electrical Review*.

employment of alternating currents, were the same; the residual discharge was insignificant. Moreover, they do not become heated. The sheets of tin were gummed to the plates of ebonite with Chatterton's compound. The sheets of ebonite were kept on a hot plate until they became soft and very supple, when the sheets of tin were applied to them by means of an ordinary iron heated. Condensers made in this way form real plates of great solidity.

The thinnest ebonite that could be procured was $\frac{1}{10}$ of a millimetre in thickness; this was not split under the tension of 11,000 volts, the highest reached. It will be possible to manufacture this ebonite of a thickness of $\frac{1}{10}$ of a millimetre.

The accompanying diagram shows the experimental method used by Messrs. Labour, Hutin, and Leblanc, for studying the qualities of different specimens of ebonite from the point of view of their mechanical resistance to high potentials. An alternator, giving about 75 periods per second, is connected with the primary circuit of an ordinary induction coil, the trembler of which is suppressed. Into this primary circuit is introduced a self-induction coil, the inductance of which may be varied by introducing into it a bar of laminated soft iron, so as to vary the intensity of the primary current, and consequently the electromotive force induced in the secondary circuit. This induced electromotive force is, moreover, increased by connecting in derivation on this secondary circuit an ebonite condenser, capable of resisting the highest tensions produced in this secondary circuit, and measured by means of Sir William Thomson's electrostatic voltmeter. In derivation on this condenser were also established two balls mounted on a frame with a micrometer screw, enabling the disruptive distances corresponding to each potential to be measured. The dielectric to be tested is placed between the two secondary wires of the induction coil, and forms a sort of condenser, with the addition of two little pieces of tinfoil applied to its surface. It is thus easy to determine for each specimen at what potentials the successive signs of deterioration show themselves, viz., splitting, luminous glow, and the appearance of holes, with very bright and powerful sparks, which will set fire to the dielectric if it is inflammable.

THE C. W. HUNT CO. COAL CONVEYER.

In many electric light and power stations the important question of coal handling has often been neglected, as well as the cost of manual labor, that has to be added to the cost per ton of fuel consumed. This is a somewhat important source of expense, and one that may be quite considerably reduced by the following mechanism,—*i. e.*, a comparatively new conveyer for bringing coal into the boiler-room from either the railroad car or from the stock bin.

Referring to Fig. 1 it will be seen that the operating mechanism is run by pawls which push the chain along, thus obviating the use of sprocket wheels. An electric motor, suitably geared, can be placed at the end of the driving shaft and suitably boxed in to keep dust out. Fig. 2 shows the buckets and chain and the trucks upon which the conveyer runs. The buckets can be made of any size suitable to the kind and quantity of coal to be conveyed. An axle extends across from truck to truck between each pair of buckets, while the buckets themselves are pivoted upon a wheel-supported bearing at each side.

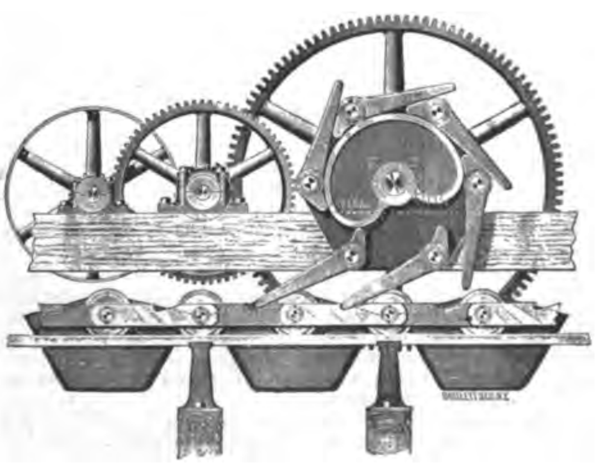


FIG. 1.—OPERATING MECHANISM, HUNT COAL CONVEYER.

The links forming the endless connection are held together and in free operative connection at the several wheel centres or axles. A pin at the side of each bucket answers as a trip for emptying purposes.

Fig. 3 shows one application of the system, and it will be seen that change of direction can be made as often as required in a vertical plane. With hoppers suitably arranged the coal is brought from the railroad car over the top of the boiler-room and dumped as required, the empty chain then going under the boilers, whence the ashes can be taken out automatically and dumped into railroad or other cars outside of the boiler-room.

The operative capacity is governed rather by the size of the buckets than by their speed of movement. The ordinary sizes are made with 28-inch links, and buckets of 2 cubic feet capacity. The regulation speed of this size of conveyer is 15 buckets per minute, delivering 40 tons of coal per hour.

FIG. 2.—DETAILS OF HUNT COAL CONVEYER.

These conveyers are now used by the Union Elevated R. R. Co., at East New York, and also at Fifth avenue, Brooklyn; at the coal docks on 20th and 56th streets, East River, New York; the Brooklyn Water Works, and many other points.

The application of the system to electric plants is proposed for the West End Street Railway Co. power station at Boston and

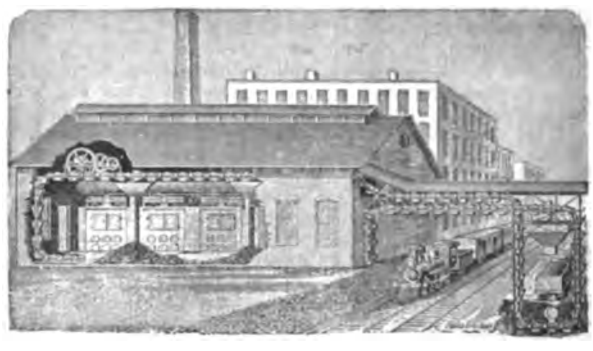


FIG. 3.—AN APPLICATION OF THE HUNT SYSTEM.

the Edison Electric Illuminating Co., in Brooklyn. The conveyer is manufactured and introduced by the C. W. Hunt Co., of 45 Broadway, New York, to whom we can advise any one interested to apply, and thereby possibly save themselves a considerable item in the cost of current production. It may be pointed out that the electric motor also furnishes a specially convenient means of propulsion for this mechanism.

AN ELECTRIC BELL FOR THE DEAF.

A "North Side" young man tells the following in the Chicago *Tribune:*

"Did it ever occur to you how a deaf and dumb man knows when his front door bell rings? I found out while making a call with a friend last Sunday. He invited me to go with him to visit a young married couple, both of whom were deaf and dumb. We made our way to a pleasant little flat building and my friend pushed the upper electric button. I asked him if they kept a servant, and when he said they didn't I inquired how they heard the bell. He said, 'They don't.' While I was wondering how they knew there was somebody at the door my friend's friend appeared. There was a little finger talk between them and he led the way upstairs. We talked awhile on pads of paper and then I told the young man I was curious to find out how he knew there was somebody at the door. He wrote: 'Come and look at our door-bell,' and led the way to the kitchen. Here I found a queer contrivance screwed against the wall about four feet from the floor. There was an electromagnet whose armature was connected with a pair of levers so that when the armature was attracted a catch was released and the hook tipped over. Hanging upon this hook was a section of a cedar post about eight inches in diameter and two feet and a half or so long. He pushed the armature against the magnet and the log dropped to the floor with a reverberating bang.

"'You can't hear that, can you?' I inquired.

"'No, I can't hear it, but we feel the jar when it falls.'"

METAL-COVERED INTERIOR CONDUITS AND ACCESSORIES.

In the wiring of buildings occasion frequently arises for insulated tubes sheathed with metal to afford better protection against mechanical injury and to prevent the action of alkalies when such tubes are run under floors or in other exposed places, and again, where they are liable to be subject to heat arising from external causes. To meet this demand the Interior Conduit & Insulation Co., of this city, have brought out the metal-covered tube illustrated in the accompanying engraving, Fig. 1, which consists of their regular tube covered with a metal sheath. Besides its fireproof and durable qualities, it possesses fine finish, which makes it readily available as a picture molding, in which case it can be held in position by screw wires or other supports, as shown in the engraving Fig. 2. For this purpose the tube is furnished in polished, oxidized and antique brass, nickel, copper, bronze, or any desired finish.

Where a double-tube system of wiring is employed as a substitute for wooden molding and concealed wiring, a twin metal covered tube can be employed to advantage. This tube is made with $\frac{5}{16}$ inch inside diameter.

In connection with the tubes, metal-sheathed junction boxes and all corresponding appliances are provided, so that the entire conduit system may be sheathed if desired. The internal appliances and fittings of the company are adapted either to the ordinary or metal-sheathed tube, but some of them are particularly adapted for the metal tube. Thus the "Universal" switch can be readily applied to this system, as shown in engraving Fig. 3, and is rendered quite unobtrusive and convenient, being in the direct line of the tube and requiring no separate branch for a switch.

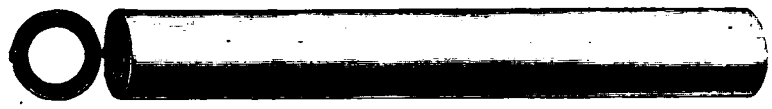


Fig. 1.

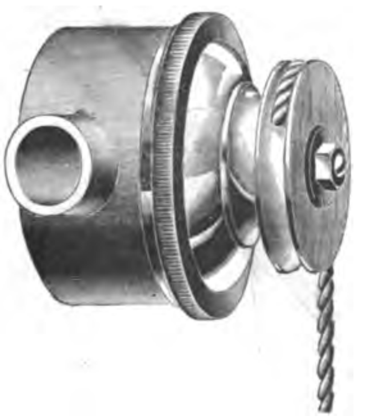


Fig. 4.

Fig. 2.

Fig. 3.

Metal Covered Interior Conduits.

Another form of switch which can be inserted directly in the circuit is shown in Fig. 4. It is especially adapted for conduit branch boxes and tubes. This is a pull switch, which can be made to operate mechanically from any convenient point by a bell cord and tassel attachment. The saving of wire and other advantages of this arrangement will appeal strongly to wiremen.

THE WHEELING, W. VA., CITY ELECTRIC LIGHT PLANT.

The city of Wheeling, W. Va., after sending a committee of its council on a tour of inspection for the purpose of selecting apparatus for the proposed city electric lighting plant, last week decided the question and voted to install the Wood arc light system of the Fort Wayne Electric Company. The plant will be equipped with 400 arc lights and will have an ultimate capacity for twelve 50-light arc machines. The motive power will consist of a 500 h. p. Hamilton-Corliss engine. The circuits will include 65 miles of pole-line construction and 100 miles of wire. Mr. John A. Seely, of this city, is retained as consulting electrical engineer by the city of Wheeling in the installation of this plant.

ELECTRIC RAILROADING AT LANCASTER, PA.

As another evidence of the increasing call for rapid transit throughout the country, the West End Street Railway Co., of Lancaster, Pa., may be cited. This company has amalgamated with the Lancaster City Electric Railway and now controls the entire street traffic of the city, the old horse system being replaced by electric power.

The power station, with car house attached, is a substantial brick building, the roof being of metal and slate, the latter being over the boiler-rooms. The dimensions of building, when first erected, were 235 x 60 feet. An additional car house has now been added, measuring 100 x 19 feet, together with an engine and boiler room, 135 x 35 feet.

The plant has been equipped by the Edison General Electric Co. and the whole of the work is of the highest order.

There are, at present, three 50 kilowatt compound-wound, self-oiling generators driven from a line of shafting furnished with Hill clutches by two 250 h. p. Reynolds-Corliss engines, built by E. P. Allis, of Milwaukee, Wis. The fly-wheels of the engines are 16 feet diameter, with 30 inches face. The pulleys are 56 inches diameter, with 16 inches face, and the pulleys of the generators are 26 inches diameter, with 16 inches face. Schieren belts are used, those for the generators being peforated.

Power is supplied from three 175 h. p. boilers furnished by C. R. Vincent & Co., Cortlandt street, N. Y. The mains from the machines are laid in troughs under the floor, supported on porcelain insulators. They consist of cable, manufactured by the Edison Machine Works, grade 4 being used. The switchboard is worthy of special mention. This is constructed of iron and slate, having two sides of iron and a top of slate. This is set on the floor and is easy of access from the rear. On the top slab are placed the different switches, safety fuses, etc., underneath being the rheostats, also with slated heads. The whole board is therefore perfectly fireproof. The positive mains are brought to a bus bar at the back of the board, from which they run to their respective switch, ammeter, etc., and thence on poreclain insulators to the tower, leaving the same through mica insulating tubes. The negative mains are brought to a common coupling, the ground wire leaving the building in the same manner as the positive mains. This ground is made directly with the rails. In addition to the ten cars which were first in operation, the company is now running eight 18 ft. and two 32 ft. cars equipped with two 15 h. p. motors each, together with six trailers. All these cars have been manufactured by the Brill Co., of Philadelphia. The company are at present operating 12 miles of track, one part extending to the little town of Millersville, five miles distant. It may be interesting to state that the mail to this town is carried by the Electric Co., and from thence by coach (also owned by the company) to Safe Harbor, 6 miles further.

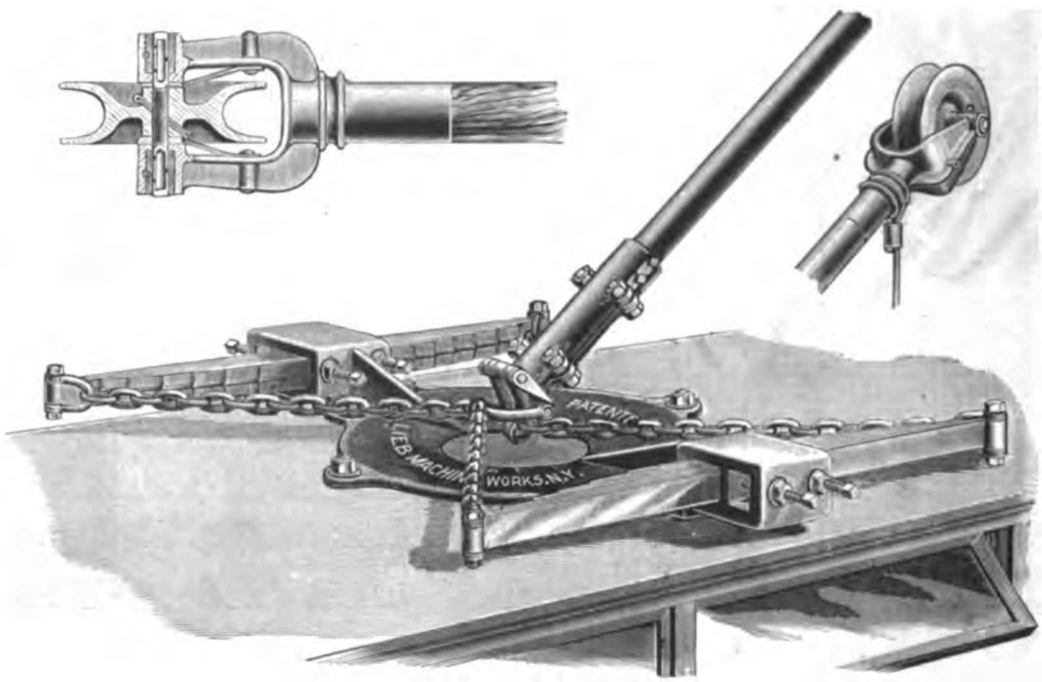
The officers of this company are as follows: John A. Coyle, president; Edward McGovern, treasurer; John Bausman, secretary; William Ring, general manager.

THE LIEB PERFECTED TROLLEY AND TROLLEY STAND.

THERE is probably no one detail of the many which go to make up the completely equipped electric car that has been the subject of more study and experiment than the trolley wheel and stand. The wheel being of necessity a small one, revolves at a high rate of speed, and is necessarily subjected to influences which tend constantly to its deterioration, and as a result much trouble has been experienced with this part of the equipment. In the Lieb perfected trolley, now being manufactured by the Lieb Machine Works, of 16 to 27 Vandewater street, this city, special precautions have been taken to avoid the difficulties heretofore met with.

The trolley, which is shown in section in the accompanying engraving, consists of a bronze wheel, which is pinned to a steel axle, so that both revolve together. The ends of the axle are bored and permit of the ready introduction of oil in the bearings, so that thorough lubrication is thus provided. The bearings are made of lignum vitæ, which material has proved to be the best adapted for this purpose. This wheel is guaranteed to run 5,000 miles.

The trolley stand, shown in the engraving, embodies several excellent principles. It will be noted that instead of employing the usual helical springs in order to obtain the proper tension, two flat steel wagon springs are employed, the four ends of which are connected to a special compensating joint. The arrangement is such that the tension or pressure of the trolley against the wire is alike in all positions of the trolley arm, and thus relieves both the car and the trolley wheel, as well as the wire, of all undue strain. The stand is so designed that the trolley wheel is able to pass under a line within five inches of the roof of the car.



LIEB TROLLEY STAND AND WHEEL.

It will also be noted that the connection between the wheel and the conductor leading to the motor is effected by means of discs pressed against the trolley wheel by springs, thus securing a firm contact.

WORLD'S COLUMBIAN EXPOSITION.

The Electricity Building, on which work has been started and is going on rapidly, will be completed about December 1st, 1891. The demand for space now aggregates something over 200,000 square feet, and in addition to this there have been received numerous preliminary applications not defining exactly the amount of space required.

Many of the applicants for space have given many interesting particulars what they are going to do, also in some cases stating the amount of money appropriated for their exhibits, and in no single case has this been less than $5,000. Such a figure as this shows the size and scope that electrical people intend giving to their exhibits.

It is estimated now that with the present space required and that called for in the preliminary applications—the latter being made on a very moderate basis, at the time of applying, as the parties were not informed that the space would be gratis—the entire Electricity Building and a portion of the Machinery Annex will be completely filled. It is, therefore, highly probable that some means will have to be devised to provide additional space, as the department of electricity will make a determined effort to give every one ample facilities. Of course, if necessary, the department will be compelled to use its prerogative in cutting down the spaces in order to make a fair and just allotment.

The Chief of Construction, Mr. D. H. Burnham, is preparing for Prof. Barrett ground floor and gallery plans and also sectional cuts of the Electricity Building, and these will be completed in the course of about two weeks. These plans will be sent out in printed form to all those who have made specific application for space, with a view to have all the applicants co-operate with the department in the final allotment of space.

ON THE ELECTROMOTIVE FORCES OF GALVANIC ELEMENTS.[1]

BY A. OBERBECK AND J. EDLER.

As amalgams in which the percentage is pretty low behave, so far as electromotive force is concerned, almost exactly as the metals themselves, an element consisting of the combination: mercury | electrolyte | amalgam was chosen, and the E. M. F. determined by the compensation method with the aid of a mirror galvanometer. The tests included the metals zinc, cadmium, tin, lead, and bismuth, in a large number of solutions of sulphates and chlorides of various degrees of concentration. In the result it appeared that the electromotive force depends principally on (*a*) the metal forming the electrodes; (*b*) on the electro negative constituent of the solution.

The order of the metals in the solution always remains the same, although their positions approach and recede from one another. The same is also true for free acids. The electromotive forces are greatest (and nearly equal) for sulphuric and nitric acids. For hydrochloric acid they are much smaller and nearly equal to those obtained with a neutral chloride. For solutions of salts the values of the E. M. F.'s follow the order: sulphate, nitrate, carbonate, chloride, bromide, and iodide. The electromotive forces only depend upon the metal of the salt in solution, when this metal is the same as that of the electrode. In this case the E. M. F. is smaller. If these results are compared with those published by J. Thomson on the heat equivalents of the above metals (except bismuth), a distinct correspondence between the differences of these equivalents and the observed electromotive forces will be noticed.

The authors arrived at the following conclusions:

1. The E. M. F. is to be calculated from the heat equivalent of the chemical process, taking into consideration the local evolution of heat that takes place at the electrodes.

2. Want of constancy in elements is due to the taking up of molecular layers of a dilute solution of the metal of the electrode. The degree of concentration depends upon many circumstances, which must be the subject of future experiments

1. *Wied Ann.*, Vol. XLII., Part 2.

COLUMBIA DYNAMOS AND MOTORS.

SINCE all dynamos and motors are based upon the same general principles, the differences in efficiency are due to the degree of correctness in design, accuracy of workmanship and quality of the materials used. Accepting this fact at the outset, the aim of the Columbia Electric Company, of St. Paul, Minn., has been to meet all these requirements, and their success is most gratifying.

The accompanying illustrations show two motors and a power generator built by this company. These machines have self-aligning bearings, self-oiling journals, and all sizes above 50-light dynamos and 5-h. p. motors have sub-bases and belt tighteners. Improved brush holders, both for copper and carbon brushes, are used on all machines, and, it will be noticed, have an independent action, as well as the double action, for placing them upon the commutator.

The power generators and dynamos, the general type of which is shown, Fig. 3, are of the same general form as the stationary motors, Figs. 1 and 2. The magnet cores of both are made of the

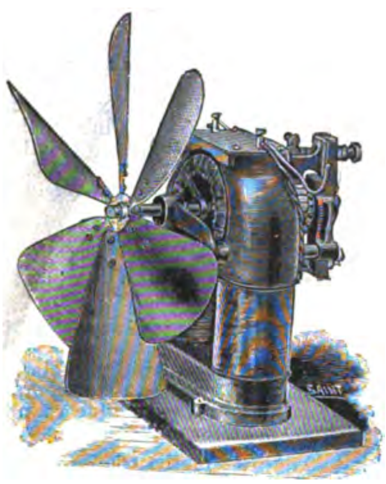


FIG. 1.

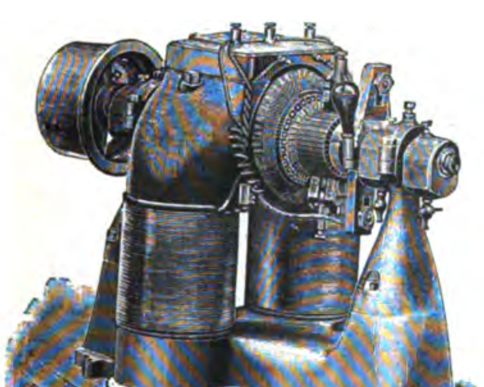


FIG. 2.

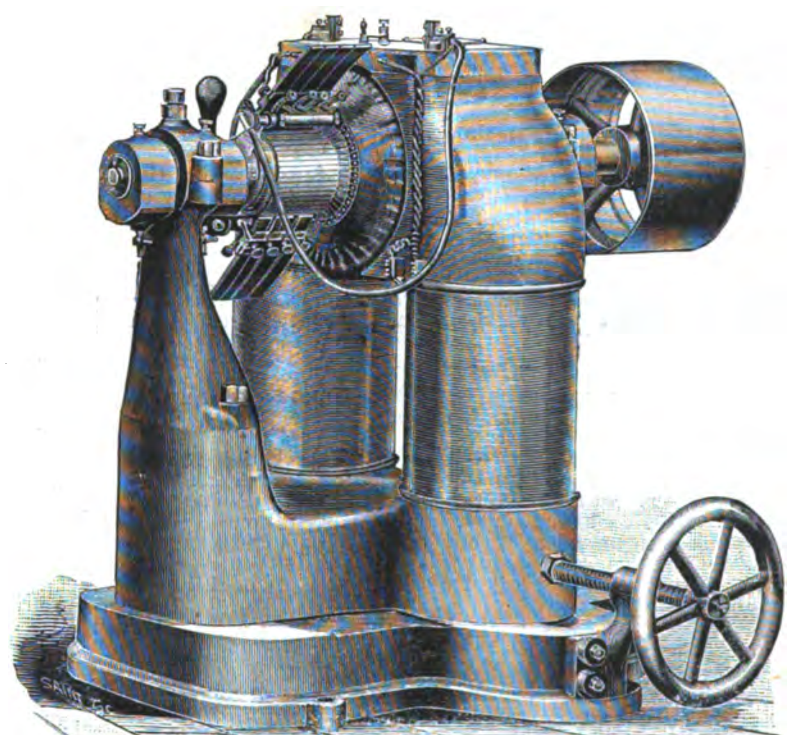


FIG. 3.

COLUMBIA MOTORS AND POWER GENERATOR.

best quality of charcoal wrought iron. The armature cores are thoroughly insulated with pure asbestos and mica, the same materials being used for insulating the spools upon which the field coils are wound. All commutators are insulated entirely with mica, and are so constructed that it is impossible for the bars to become loose.

These machines are wound either shunt or compound for any standard E. M. F., and the shunt machines and motors are provided with indestructible rheostats. The compound dynamos maintain a constant E. M. F. either at the machine or at the distributing point on the line.

In electrical efficiency and mechanical design these machines are claimed to be second to none. They are automatic in action and practically noiseless.

MR. H. T. PAISTE, the energetic and well-known switch manufacturer, has thrown off his business cares, and fled to the mountains of Virginia for a few weeks' recreation.

THE NEW WESTINGHOUSE ELECTRIC RAILWAY AT KANKAKEE, ILL.

AMONG the latest street railroads equipped by the Westinghouse Electric & Mfg. Company is that at Kankakee, Ill. This is a most charming summer resort, beautifully situated on the Kankakee River, between fifty and sixty miles from Chicago, and is becoming every day more popular with the city residents. In addition to its great natural beauty, which places it in the front rank of delightful spots for a summer outing, it is a solid and prosperous business town, having several big factories employing a large number of hands. The sporting element also has not been forgotten, as there is one of the finest race tracks in the country located there. The river a few miles above the town also is noted for its excellent fishing.

The advent of an electric street railway shows the progressive and enterprising spirit of its business men, and the growth of the town in population and new enterprises will increase rapidly, as is always the case where rapid transit is to be found.

The road is owned by the Kankakee Electric Railway Co., of which Mr. T. F. Andrews is president; Mr. T. W. Adams, treasurer; Mr. Carpenter, secretary, and Mr. Charles H. Cobb, general manager. The first car was started over the road on July 19th, but the formal opening took place on the 25th, when a party of people interested in such matters, among them representatives of the technical press, at the invitation of Mr. J. Livingstone Barclay, the manager of the Westinghouse Company in Chicago, and Mr. W. R. Mason, of the Electric Merchandise Co., went down to inspect the new line, which was unanimously voted an unqualified success.

The road built at present is somewhat over five miles long, with four motor cars now running. Trailers are to be immediately added, and additional lines will shortly be built.

The motor equipment was furnished by the Westinghouse Co., 20-horse power, 4-pole single-reduction motors being used. A noticeable feature of this system is that the gears are incased and run in oil, which renders them practically noiseless, and adds greatly to the comfort of the passengers. The principal streets on which cars are now running are Court, Harrison, East avenue, Merchant, Greenwood avenue, and Jeffries street.

All the line material and equipment supplies were furnished by the Electric Merchandise Co., of Chicago, who make the manufacture of, and dealing in, electric street railway supplies for all systems their exclusive business, and whose material is now to be found on almost every street railway plant in the country.

The cars were manufactured by the Pullman Company and are as handsome as any ever turned out. They are 16 feet long and mounted on "Hubbard" trucks, made by the McGuire Mfg. Co., of Chicago. The overhead construction was done by Mr. W. W. Hatch, of Kankakee, and the track-laying by Mr. C. E. Loss, of Rochester, N. Y. The work throughout has been done in the best possible manner.

The current for operating the road is furnished by a 500-volt 80 h. p. Western Electric railway generator, which is installed in a portion of the Electric Light Co.'s power house, and is driven by a 90 h. p. Paine engine, steam being supplied from the well-known Hazelton tripod boilers.

Reports of Companies.

AMERICAN BELL TELEPHONE CO.

The instrument output of the Bell Telephone Company for the month ended July 20, and the seven months of the company's fiscal year, is reported comparatively as follows:

Month ended July 20 —	1891.	1890.	Inc.
Gross	4,699	4,787	*88
Returned	4,638	2,887	1,751
Net	61	1,900	*1,839
Since Dec. 21—	**1890-91**	**1889-90**	**Inc.**
Gross	42,623	38,364	4,259
Returned	23,399	14,991	8,408
Net	19,224	23,373	*4,149

*Decrease

EASTON ELECTRIC CO.

The Sheriff has received an attachment for $15,000 against the Easton Electric Company, lately of 65 Broadway, in favor of Samuel Rowland on promissory notes of the company made a year ago, which were endorsed by P. Minturn Smith, the former president, and W. D. Perry, vice-president. Judgments for $2,395 have been taken against the company in favor of Murphy & Metcalf for professional services. The factory of the company was at 643 Kent avenue, Brooklyn. Ex-Mayor Wickham was its first president.

NORTH AMERICAN UNDERGROUND TELEGRAPH AND ELECTRIC CO.

There have been filed two executions aggregating $83,580 against the North American Underground Telegraph and Electric Company, formerly at 43 Broadway, in favor of Louis May, but no property could be found to levy upon. The company was formed several years ago with a capital stock of $5,000,000 to work the Johnstone iron conduit system for underground wires, but it was not favorably looked upon by the Board of Electrical Control.

DIVIDENDS.

The Thomson-Houston Electric Co. has declared a quarterly dividend of $1 per share, payable August 15.

The Eddy Electric Manufacturing Co. has declared a quarterly dividend of 2½ per cent., payable on demand.

Society and Club Notes.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.

The annual convention of this Association announced to begin on August 11, in this city, will be held at the Murray Hill Hotel, Park Avenue. The outlook is most promising, and recent events tend to give it far more than ordinary importance. The proceedings will begin at 10 A. M., on Tuesday, and during the day the following items of the programme will be taken up: Report of committee on the Prevention of Damage from Crosses of High Tension Circuits, by C. P. Gilbert, of Detroit, chairman; report of the committee on Lightning Protection, by A. E. Kennelly, of the Edison Laboratory, chairman, and the results of experiments at the laboratory on new forms of lightning arresters; report of committee on Grounding the Neutral Wire in Three-Wire Systems, by A. E. Kennelly, chairman; report of committee on Fuel Gas, by J. R. Markle, of Detroit, chairman. There will also be a visit to the office and stations of the Edison Electric Illuminating Company, of New York, in response to an invitation from the company to inspect the special features of their three plants, and plans for the proposed comprehensive station near the City Hall.

The following is the programme for Wednesday:

Address by officers of the Edison General Electric Company as to matters of commercial interest to the Association and the patent litigation; "How to get a Paying Load for Stations," by William D. Marks, of Philadelphia; "The Meters in Use in the Station of the Brooklyn Company," by R. S. White; "How can our Association best Serve Central Station Interests," by Frederic Nicholls, of Toronto; paper by W. L. Garrison, of the Brockton, Mass., Company; "Important Details in Underground Conductors," by Mr. Stevenson, of the New York Illuminating Company; "Some Practical Ideas on Distribution," by Leigh Carroll, of Birmingham, Ala.; paper by C. L. Edgar, of Boston; "Peculiar Features of the Edison Feeder System," by Wilson S. Howell; "The Success of the Mutual Insurance Idea in Electric Light and Power Stations," by secretary Jenks; paper by H. J. Smith, of the New York Illuminating Company.

Visit to the station of the Edison Electric Illuminating Company, of Brooklyn, in response to an invitation by the officers of that company.

On Thursday, the delegates will be given an excursion to Schenectady, by special train, by the parent company; and an opportunity will be afforded of visiting other of the manufacturing establishments around New York. Possibly the exercises may run over to August 14. The New York Electric Club, with its wonted hospitality, has tendered to the convention the privileges of the club-house during the week. The officers of the Association are: John I. Beggs, president; C. L. Edgar, vice-president; W. J. Jenks, secretary; and W. S. Howell, treasurer.

Appointments, Etc.

Mr. Gano S. Dunn, who graduated recently from the Columbia College electrical engineering course, has become associated with the Crocker-Wheeler Motor Co. as its electrical engineer, and is now actively engaged on important work for that concern.

Mr. D. C. Jackson, electrical engineer of the Chicago Edison branch office, has accepted the chair of electrical engineering at the State University of Wisconsin.

Mr. J. Harper, superintendent of the Jasper County, Mo., Electric Light & Power Co., has gone to Nevada to become treasurer of Asylum No. 3.

Mr. H. Coulter, of Kansas City, has been appointed manager of the telephone exchange at Leavenworth, Kansas.

Mr. H. L. Griffith joins the forces of the Dubuque Street Railway Co. as electrician.

Letters to the Editor.

THE GERMAN INDEX.

Regarding that most excellent index to periodical literature mentioned in your leader upon "Scientific Note Making," Vol. XII (No. 168), p. 92, issue of July 22, 1891, namely, "Die Fortschritte der Elektrotechnik," it may be well to state that the last number received to date by subscribers is the one for the last quarter of the year 1889, so that any one depending on it alone (and it is the best work of its kind) will be a year and a half behind the times, enough to put any one out of the race. It has further value than a mere index because of the abstracts of articles and its references to all reviews of electrical books.

J. STANFORD BROWN.

New York City, July 29, 1891.

ANOTHER ELECTRIC ROAD FOR BRAZIL.

A contract for an electric railway to be installed in Brazil was taken by Mr. Benjamin Blum, who will send a sample installation consisisting of one car with 25 h. p. motors; one 50,000-watt generator and all station apparatus and entire equipment for 1¼-mile track. This is for a narrow-guage road, and if successful, the entire road (consisting of 60 cars) is to be equipped by him.

Mr. Wm. M. Mordey, the English electrical engineer, arrived in this city from England on July 30, on a brief vacation. Unfortunately he will spend only a couple of weeks in this country, but proposes to make the most of his time in a flying excursion.

Literature.

Primary Batteries. By Henry S. Carhart, A.M., Professor of Physics in the University of Michigan. Sixty-seven Illustrations. *Boston. Allen & Bacon,* 1891. Pp. 193, ix ; $1.50.

In view of the fact that for half a century the primary voltaic battery constituted an essential part of every apparatus for the utilization of electricity, both for scientific and industrial purposes, it is certainly very remarkable that until now no one has apparently thought it worth while to prepare a special treatise in the English language on this subject. It cannot be truthfully affirmed that there has been no need for such a work, for notwithstanding the considerable amount of material of more or less value (generally less) to be found in the various treatises on the general subjects of physics, electricity, and telegraphy, and that embodied in papers scattered through technical journals, or entombed in the transactions of learned societies, the fact has been patent that most of the persons to whom the care of batteries has hitherto been committed have evinced an amount of ignorance of the subject little less than phenomenal. The Western Union Telegraph Company alone has in daily service more than 300,000 cells of sulphate of copper battery, under the care of some 20,000 different employees, not one per cent. of whom, it is safe to assume, ever received one word of intelligent instruction as to the most efficient and economical methods of management. The aggregate value of material consumed in these batteries must be nearly half a million dollars per year, at least one-quarter of which is absolute waste, due partly to carelessness, but much more to the total lack of intelligent instruction. The figures might be doubled by including the railway and other telegraphs, fire alarms, and signal and amateur batteries of various kinds.

It would afford us much gratification to be able to announce that Prof. Carhart's little book would be of great service to the benighted classes above referred to, but, on the contrary, we regret to be compelled to say, that while it is a most excellent treatise so far as it goes, its practical value is greatly lessened by the absence of detailed and specific instructions as to the care of batteries, the quantities and values of materials consumed in them, and other like information adapted to every-day use. From a theoretical standpoint, however, the work deserves hearty commendation. The distinction between electromotive force and potential, for example, which has always been a notorious stumbling-block in the path of the student, has been made so plain that the dullest cannot misunderstand it; and the fallacy of accepting as true under all, and even under most, practical conditions, the venerable dictum that the maximum effect of current in a circuit is obtained when the resistance, within and without the battery are equal to each other, is disposed of in a brief but admirable exposition of principles, which is a most valuable addition to electrical literature. The importance of making due allowance for the time-constant of the circuit in all electrical calculations is insisted upon, and is well illustrated by examples. Especially to be commended are the excellent chapters on Standards of Electromotive Force and on Battery Tests. In the latter the most recent and approved methods of determining the constants and electrical dimensions of different voltaic combinations, and of reducing the results to graphic curves, receive the attention which the practical importance of the subject demands. The descriptive matter relating to the different forms of cells in ordinary use, while excluding, as it should do, the innumerable ruck of inventions—new and old—which have neither utility nor real novelty to recommend them, in some instances leaves much to be desired. For example, it adds but little to the sum of human knowledge to be told, as we are on page 58, that the depolarizing solution of a certain commercial battery is "one of the best substitutes for nitric acid," so long as we are given not the slightest hint as to its ingredients.

The typographical execution of the work is praiseworthy, while the illustrations are generally sufficient for their purpose.

THE ELECTRICAL CENSUS OF THE STATE OF NEW YORK.

Upon the recommendation of Mr. Allen R. Foote, Hon. Robert P. Porter has appointed Mr. Horatio A. Foster special expert agent for the collection of statistics relating to the electrical industries for the State of New York. In making the appointment, it is the intention of the Census Office to complete the work for the State of New York, and to publish the results in a special bulletin at the earliest practicable date. It will therefore be the good fortune of this State, not only to have the benefit of the publication in advance of all other States, but also the honor of being first in the series of bulletins to give the results of the Electrical Census of the United States. For these reasons the Census Office, and all interested in this department of its work, are extremely anxious to have the report for New York complete and accurate in every detail. It is especially desirable that every person in the State in any way interested in the electrical industries shall cordially co-operate with Mr. Foster in facilitating his work, and furthering the general interests involved.

Mr. Foster will visit every electric central station, electric railroad, and the more important insolated plants in the State, and assist their superintendents in correctly filling the official schedule. All schedules that have been sent to Washington are put into his hands for correction and verification.

While the temptation will be very great to cause Mr. Foster to spend a little extra time at each station in talking over details of construction and management that are so intensely interesting to those in charge of stations, it is hoped that each superintendent will keep the fact in mind that one great point of value in Mr. Foster's work will be the quickness with which it can be completed. A very great service will be rendered by each superintendent if he will earnestly endeavor to assist in completing the work, so far as his station is concerned, in the shortest possible time consistent with accuracy. In a work as extended as this every half hour is valuable.

To assist in saving time it is suggested that each superintendent should have a correct memorandum for Mr. Foster, covering the following details :—

1. Average number of poles per mile.
2. Kind of wood.
3. Number of poles, part wood and part iron.
4. Total length of conductors on poles.
5. Total length of conductors on housetops.
6. Total length of conductors on bridges.
7. Total number of service connections.
8. Number of service connections on each alternating current main.
9. Total cost of all aerial conductors.
10. Total annual cost of maintaining all aerial conductors.

Mr. Foster will give each company due notice of the date when he will call for the purpose of finishing up its schedule and will give all the assistance that may be necessary.

It is the opinion, without exception, of all who know Mr. Foster personally, and of those who have read his recent articles on "Central Station Management and Finance," that no other person is as well fitted as he is, in all particulars, for the work he is to undertake. We congratulate the companies of the State of New York, and all interested in the electrical industries throughout the country, that this work is in such competent hands, and bespeak for him a cordial reception and every desired assistance from all persons upon whom he may call.

WOODHOUSE & RAWSON AT THE NAVAL EXHIBITION.

Among the numerous exhibits of private firms at the Naval Exhibition now open at Chelsea, London, is that of Messrs. Woodhouse & Rawson, United, Limited, of London. The exhibition

Woodhouse & Rawson Launch "Electric."

being primarily devoted to objects connected with naval warfare, we are reminded that this enterprising company have just completed to the order of the British Government the launch "Electric," of which we give an illustration. This has been specially designed for the conveyance of troops from one part of Chatham Dockyard to another, but it is intended to carry out with it an extended series of trials, so that the merits of electricity as applied to the propulsion of small vessels may be thoroughly investigated.

At the company's launch works, near Kew, there are at present several launches, varying in size up to 50 feet in length, in course of construction. Models are shown of some recently delivered, among which we notice one, the "Golondrina," 53 feet long, which has been built for the Mexican Government. Although some of these are steam launches, it is satisfactory from an electrical engineer's point of view to know that the demand for electrically propelled boats is increasing so rapidly that the company have felt it to be necessary to open a charging station near the works, where the accumulators may be recharged.

To show how easily electricity lends itself to launch propulsion the manager of the company's boat-building department has constructed a working model in which the screw is attached directly to the axle of the armature of the motor.

While search lights of all sizes are shown at this exhibition, the company has a model which they anticipate will soon find favor with the naval authorities. Instead of a mechanically worked arc, the light is obtained from an incandescent block of marble. This lamp was introduced some years ago as the "Sun" lamp, but owing to defects in design it did not meet with much favor. It has, however, now been perfected, and is about to be reintroduced. Its perfect steadiness and freedom from mechanism are its great merits.

The advantages of the single-stroke Jensen bell, particularly as adapted for signaling purposes on board ship, are shown, while it is almost needless to say that the quick-break switches for which the company is so well known are also shown. Both in the sample of the 1,000 ampere and the three-way 500 ampere types the sockets are arranged for "sweating in" the cables.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JULY 21, 1891.

Clocks:—

Secondary Electric Clock Movement, B. Haberthur, 456,325. Filed Nov. 8, 1890.

Conductors, Conduits and Insulators:—

Flexible Conduit for Electric Conductors, C. H. Herrick, 456,271. Filed April 17, 1891.
Composed of a spiral lining, a protective wrapping applied to cover the separations between the turns of the spiral, and an inclosing envelope.

Conduit for Electric Cables, M. Delafor, 456,376. Filed Aug. 15, 1890.
Conduit has a removable cover, the joint between cover and conduit following a broken line transversely.

Lamps and Appurtenances:—

Cut-Out for Electric Lamps, W. F. Smith, 456,327. Filed Apr. 24, 1891.

Search-Light, W. E. Hadlock, 456,408. Filed Mar. 12, 1890.
A support and mounting for an electric lamp for search-light use.

Medical and Surgical:—

Electro-Therapeutic Apparatus, E. Grauert, 456,219. Filed July 16, 1890.
An electro-medical apparatus including a chloride of silver battery and special construction of parts.

Metallurgical:—

Magnetic Separator, H. G. Fiske, 456,507. Filed Mar. 26, 1891.
The mass of material to be separated is fed through the field of a moving series of magnets at a speed different from that of the magnets; the mass while traveling is subjected to continued reversals of the polarity of the magnets; the movement of the mass is in opposition to a current of fluid.

Metal Working.

Method of Welding by Electricity, J. H. Bassler, 456,540. Filed Aug. 16, 1888.
Applicable to the welding together of sheets, such as boiler plates, at their edges.

Method of and Apparatus for Electric Welding, S. L. Wiegand, 456,541. Filed Dec. 9, 1889.
Adapted to the welding of metal parts of such forms and dimensions as will not permit the entire weld to be effected simultaneously, but which require a progressive process.

Measurement:—

Method of Measuring Electric Currents, E. Thomson, 456,172. Filed Oct. 19, 1887.
Consists, essentially, in using an electrical current to generate heat, vaporizing a liquid by the heat, and noting the amount of vaporization as a measure of the electricity employed.

Miscellaneous:—

Electric Lock, A. S. Wiley, 456,182. Filed Apr. 9, 1891.

Insulated Contact for Electric Switches, O. S. Platt, 456,250. Filed June 4, 1890.
Employs porcelain buttons or bushings.

Operating Mechanism for Current-Regulators, S. H. Short, 456,253. Filed Mar. 10, 1891.
Relates particulary to rheostatic switches for the regulation of electric railway motors and operated from the car platforms.

Rheostat, J. Van Vleck, 456,280. Filed Jan. 19, 1891.
Designed to enable the coils of a rheostat to be thrown into or out of circuit by a small movement of the handle or lever.

Phonograph, T. A. Edison, 456,302. Filed Aug. 12, 1890.
Relates to the feeding devices.

Double-Contact Switch, T. H. Lovell, 456,493. Filed Dec. 2, 1890.
Especially adapted to use with currents of high potential.

Railways and Appliances:—

Trolley, J. E. Kinney, J. H. Brown & C. G. Wade, 456,148. Filed Oct. 20, 1890.

Connector and Support for Trolley-Wires, S. H. Short, 456,252. Filed Oct. 29, 1890.
Adapted for use with sectional trolley-wires.

Switch for Electric-Car Motors, S. H. Short, 456,254. Filed April 7, 1891.
Adapted for use upon electric railway cars equipped with four or more motors each, and provides means for connecting the motors in series, in multiple series, or in multiple arc.

Electric Railway R. M. Hunter, 456,513. Filed July 14, 1885.
Includes a contact device supported upon a laterally movable frame, the contact device having a self-sustaining, free-swiveling movement about a vertical axis.

Electric Railway, R. M. Hunter, 456,514. Filed Sept. 28, 1888.
Relates particulary to the arrangement of conductors upon a main line and a branch line.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JULY 28, 1891

Accumulators:—

Electrode for Secondary Batteries, O. C. Flick, 456,558. Filed Jan. 3, 1887.
The electrode is made by casting or placing pure metallic lead into apertures or recesses, or upon the surface, of a plate of a metal or alloy not affected by the exciting liquid of the battery; then converting the metallic lead into a carbonate or other salt, and then converting the carbonate or other salt into spongy or granular lead while held in the cavities of the plate.

Secondary Battery, H. Pieper, 456,843. Filed Oct. 17, 1888.
Seeks to increase the capacity of batteries and facilitate their depolarization by maintaining within the battery-fluid gases in solution under pressure.

Alarms and Signals:—

Spout-Alarm for Grain-Bins, W. G. Adams, 456,667. Filed Dec. 18, 1889.

Annunciator, W. C. Dillman, 456,803. Filed May 6, 1891.
For use in connection with speaking-tubes.

Conductors, Conduits and Insulators:—

Cable-Head for Electric Wires, U. H. Balsley, 456,611. Filed Jan. 12, 1891.
Adapted for use with telegraph and telephone cables.

Attachment for Poles for Electric Wires, E. Verstraete, 456,663. Filed July 7, 1890.
Includes an insulating cap fitted on the end of a pole.

Distribution:—

System of Electrical Distribution, M. Feilbogen, 456,868. Filed Sept. 22, 1890.
A system for changing a constant current into an interrupted or pulsating current, adapted to a system of distribution employing converters.

Electric Circuit-Breaker for Secondary Generators, M. Feilbogen, 456,869. Filed Sept. 22, 1890.
Apparatus for use with the system noted next above.

Dynamos and Motors:—

Regulation of Dynamos Driven by Compressed Air, V. Popp, 456,598. Filed Apr. 7, 1888.
The output of the dynamo is controlled by an automatic regulator actuated by combined pnuematic and electric apparatus.

Electromotive-Force Regulator, E. M. Bentley, 456,612. Filed Oct. 21, 1890.
The method of regulating dynamos or motors consists in employing two sources of electromotive force and completing the circuit of each source through a variable portion of the other source.

Alternating-Current Motor, M. Von Dolivo-Dobrowolsky, 456,804. Filed Dec. 23, 1890.
Relates to the class of motors driven by a plurality of alternating currents of respectively differing phases.

Armature for Motors and Generators, N. C. Bassett, 456,925. Filed Feb. 27, 1891.
Relates to armatures of the type called "iron-clad." The coils instead of passing over the periphery of the armature core are passed through perforations near the periphery.

Ignition:—

Electric Gas-Lighter, A. Wunderlich, 456,684. Filed Apr. 7, 1890.

Automatic Electric Gas-Lighter, A. Wunderlich, 456,685. Filed Dec. 5, 1890.

Lamps and Appurtenances:—

Electric Arc Lamp, F. L. Sautter, 456,598. Filed Dec. 18, 1890.
Relates to the means of automatic regulation in focusing lamps.

Electric Light Crane, C. H. Shank, 456,859. Filed Jan. 10, 1891.

Medical and Surgical:—

Medical Induction-Coil, H. A. Voelkner, 456,746. Filed Jan. 28, 1891.
Employs two current-breakers vibrating at different rates of speed arranged in series in the primary circuit.

Metallurgical:—

Magnetic Separator, D. E. Lain, 456,622. Filed Aug. 2, 1890.
Combines a hollow cone of magnetic metal, two spiral rows of projections of magnetic metal from the external surface of the cone to form cores of electromagnets; a continuous spiral pole is provided for each of the two rows of cores.

Miscellaneous:—

Magnetized Head for Drawing Instruments, R. S. Carr, 456,553. Filed Aug. 4, 1890.

Coin-Controlled Electrical Apparatus, T. L. Brooks, 456,718. Filed May 19, 1890.

Clutch, W. H. Johnson, 456,827. Filed Apr. 1, 1891.
For use with dynamos.

Electric Condenser Regulator, J. McBride, 456,835. Filed Sept. 24, 1890.
Relates to apparatus for controlling automatically the supply of cold water to condensers in accordance with the quantity or pressure of the vapor to be condensed.

Show-Stand, J. W. Tyler, 456,865. Filed Mar. 12, 1891.

Electric Hoisting Machine, G. H. Reynolds, 456,908. Filed Dec. 27, 1890.
Especially applicable to elevators. Control is secured through the employment of variable resistances.

Railways and Appliances:—

Span-Wire Insulator, W. S. Jarboe, W. P. Siebert and J. White, 456,574. Filed Nov. 28, 1890.

Span-Wire Insulator, W. P. Siebert, 456,600. Filed Dec. 13, 1890.

Railway Signaling Device, W. Newcomb, 456,836. Filed Dec. 23, 1890.
Relates to visual signaling between moving trains.

Telephones and Apparatus:—

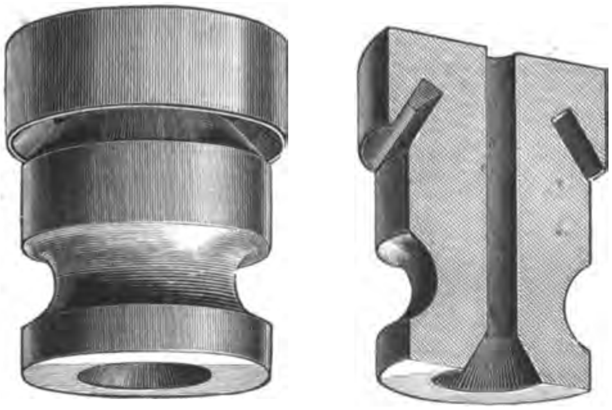
Electric Circuit-Changing Apparatus, H. V. Hayes, 453,817. Filed Feb. 3, 1891.
Relates to switching apparatus for use in connection with telephones; the apparatus shown was designed especially as a marine telephonic outfit for use on shipboard.

TRADE NOTES AND NOVELTIES
AND MECHANICAL DEPARTMENT.

"If you want to drop out of business, drop out of the papers."—C. M. Wilkins, of Partrick & Carter Co.

NEW CENTRAL ELECTRIC INSULATOR.

THE accompanying cut illustrates a porcelain insulator of new design. The slot around the base of the insulator, inclining

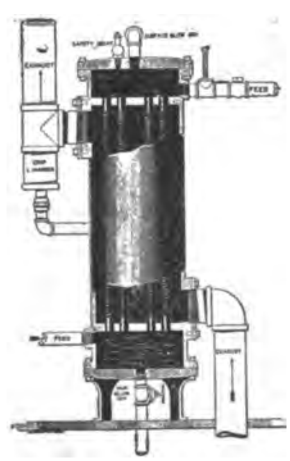


NEW CENTRAL ELECTRIC INSULATOR.

downwards, effectively prevents a line of moisture covering the insulator from the conductor to the supporting base. These insulators are highly glazed, have a countersunk base, and are spoken of very highly by those who have used them. They are being placed on the market by the Central Electric Company, of Chicago.

THE WAINWRIGHT CORRUGATED WATER-TUBE HEATER.

THE economic production of steam in an electric light or power plant is one of the most important factors of success, and results of the boiler, steam engine, and appurtenances largely control the question of dividends to the stockholders. Hence, every improvement to steam engineering applicable to electric plants is of interest to the electrical engineer, and we therefore illustrate in the accompanying engraving the latest type of corrugated water tube heater, designed and manufactured by the Wainwright Manufacturing Company, of Massachusetts, Boston. This heater has been designed specially and possesses many points of



THE WAINWRIGHT CORRUGATED WATER TUBE HEATER.

superiority, being provided with a settling chamber and a surface blow off.

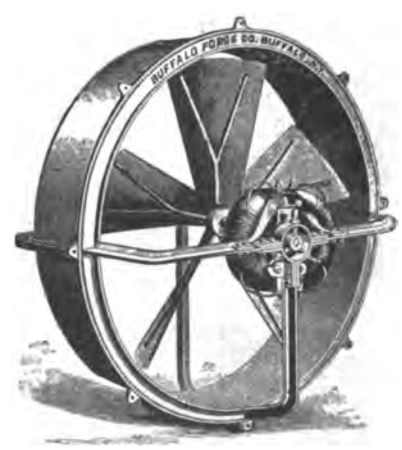
It is universally admitted that a straight tube heater, provided with proper means of blowing it off, and built so that it gives a chance for the impurities of the water to settle and be disposed of, is in every way by far better than a heater in which the water has no chance to settle, but allows all the impurities to pass into the boiler, there creating the chance of fouling and burning out the boiler.

An ordinary straight tube heater however, entails a heavy cost to prevent any possibility of leakage at the joints owing to the expansion of the tubes, but with the corrugated tubes it is entirely different, as the corrugations themselves take care of the expansion and contraction, and enable the manufacturer to make a heater which is practically perfect, and at the same time at a very low cost. The tubes are all of the best Lake Superior copper, and their durability is beyond question.

BUFFALO ELECTRIC DISC FAN WHEELS.

THE engraving herewith illustrates the improved electrical wheel just perfected and placed on the market by the Buffalo Forge Co., Buffalo, N. Y., U. S. A. As clearly shown, the motors are built as a part of the fan and require only a minimum power for driving. Any position suited to the maximum efficiency of the fan may be employed without affecting the arrangement of the motor. The fans are of high grade, carefully balanced, and the entire outfit is designed for quiet running at high speed. The motors are of the most approved style and type, especially constructed for fan propulsion, and capable of continuous use with little attention. The high speed at which it is possible to run these wheels gives them large capacity, so that a smaller fan, occupying little space, can be used to ventilate apartments of considerable size.

The above-named enterprising house not only build every type of fan and blower for all possible uses, but also manufactures a popular heating and ventilating system for all large buildings. It is known as the Buffalo "Hot Blast" or "Fan System" apparatus. Buffalo steel pressure blowers, "B" blowers, are well known to the trade as among the most durable blowing machines extant. Numerous Buffalo steel plate fans are now being used for the ventilation of mines with the greatest success. They are built both with single and double vertical and horizontal engines,



BUFFALO ELECTRIC DISC FAN WHEEL.

according to the work they are to perform. It is not uncommon to see these fans 20 feet in diameter when used for the above purpose. Aside from the above lines, this house manufactures a complete line of blacksmith tools, including portable and stationary forges, drills, punch, shear and bar cutters. It will be their pleasure to furnish complete catalogues covering the entire line of their manufacture.

THE SIOUX CITY ENGINE WORKS.

The Sioux City Engine Works report a constant improvement in their business, as indicated by an increased number of orders. They are still continuing their night force, and the indications are that it will be very largely increased in order to keep up the record, so far unbroken during the present season, of shipping everything ahead of contract time. They have recently shipped and are now erecting two 18 x 42 and one 12 x 36 Corliss engines for the Moline Plow Co., Moline, Ill. Two 12–22 x 36 compound condensing engines for the Waco Electric Light & Railway Co., Waco, Texas. One 16 x 36 to Leonard, Atkinson & Co., for their shoe factory, at De Kalb, Ill. One 16 x 36 to W. C. Ritchie & Co., for their box factory, Chicago, Ill. One 14 x 36 Corliss engine for a flouring mill at Savannah, Mo. One 9 x 14 Giddings automatic for electric lighting at Sioux City, Iowa. One 6–10 x 16 compound automatic for the factory of the New England Investment Co., Sioux City, Iowa. One 9 x 14 Giddings automatic for the Poch Mfg. Co., Leeds, Iowa. One 18 x 36 to the Northwestern Sewer Pipe & Tile Co., Sioux City, Iowa.

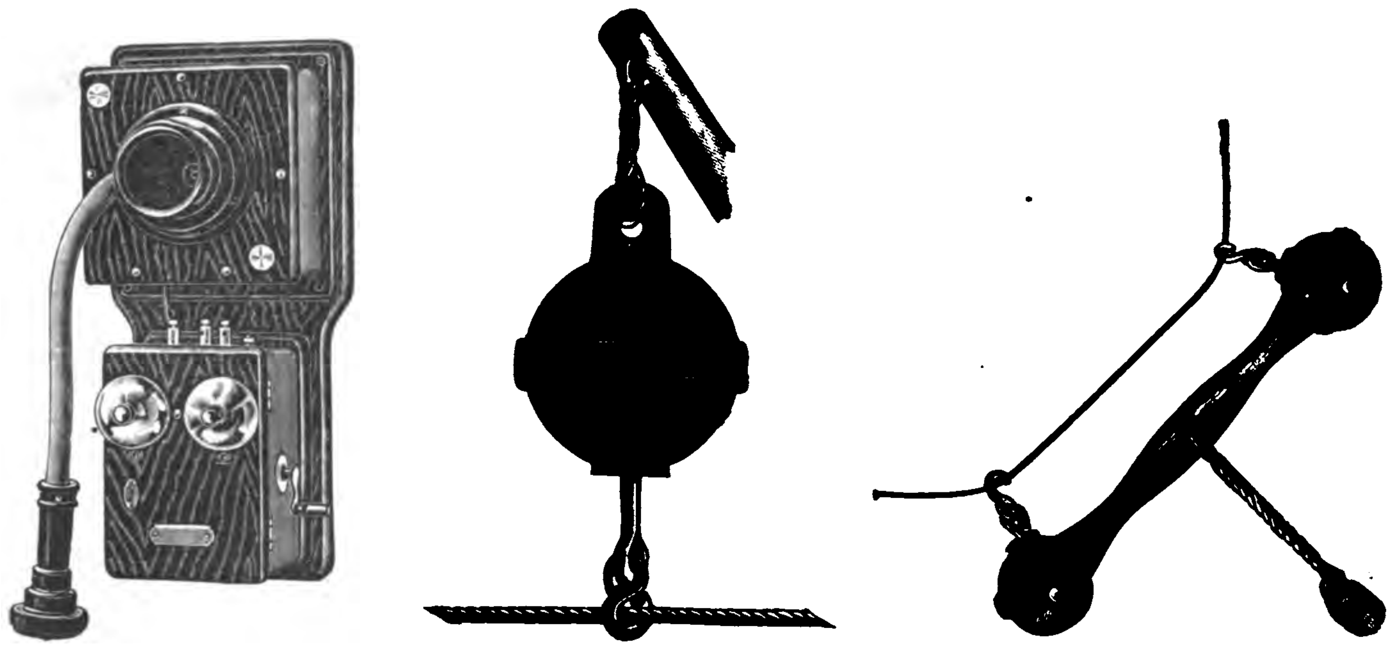
Among the orders booked the past week are: One 14 x 36 for a grain elevator in Chicago. One 18 x 36 for the Dubuque Electric Street Railway, Dubuque, Iowa. One 18 x 36 for Le Mars Water & Electric Light Co., Le Mars, Iowa. One 18 x 42 and one 12 x 36 Corliss with Stirling boilers for the new paper mill at Salina, Kansas. One 11 x 24 Corliss for a flouring mill at Sanbourn, Iowa. One 14 x 36 Corliss for the Illinois Chair Co., Rockford, Ill.

SIOUX CITY, IA., IRON WORKS.

Mr. C. M. Giddings, president and general manager of the Sioux City Iron Works, reports having sold in Dubuque, Ia., on a recent trip a 150 h. p. Corliss engine to run the generators of the Rhomberg electric street railway line. One of their erectors is at Moline putting up four large engines, and another is at Rockford putting in an engine there. Within the past 4 months they have placed 10 large engines along and east of the river, a fact that shows the estimation in which the Sioux City engines are held. They are now running their works night and day, and have several large contracts ahead for early execution. This make of engine bids fair to become well known in the electrical field, as it is being pushed, and finds marked appreciation.

THE STANDARD NON-ELECTRIC TELEPHONE.

In order to supply the prevalent demand for a practical short-distance telephone that could be sold outright, the Bostwick & Burgess Manufacturing Co., of Norwalk, O., have recently produced the instrument shown in the accompanying illustrations. Here Fig. 1 shows the telephone mounted and provided with magneto-bells. Extension bells may be placed in other parts of the building if desired. No battery is used in this system, and any one of ordinary intelligence can, it is claimed, put up the line.



FIGS. 1, 2 AND 3.—STANDARD NON-ELECTRIC TELEPHONE.

The insulators are of rubber incased in a metal shell, which protects them from the weather. From the rubber hangs a galvanized wire hook, through which passes the line wire, as shown in Fig. 2. These insulators are throughly practical and durable, and may be used as electric insulators also.

The difficulty experienced in working around sharp angles has been obviated by the use of the angle insulator, shown in Fig. 3, which consists of two single insulators pivoted to a malleable iron yoke. The engraving is one-half of the actual size.

RECENT SALES OF BALL ENGINES.

Below we give a list of recent shipments of the Ball Engine Co., Erie Pa.: Temple Bethel, New York City, two 80 h. p. engines; Johnson Co., Johnstown, Pa., three 150 h. p. engines, one 300 h. p. cross compound engine; Frishmuth Bros. & Co., Philadelphia, Pa., one 25 h. p. engine; Gambrinus Stock Co., Cincinnati, O., one 25 h. p. engine; Bennett, Sloan & Co., New York City, one 25 h. p. engine; Allentown Rapid Transit Co., Allentown, Pa., two 125 h. p. engines; Lebanon Street Railway Co., Lebanon, Pa., one 50 h. p. tandem compound engine; Edison General Electric Co., New York City, one 80 h. p. engine; E. T. Copeland & Co., New York City, three 80 h. p. engines, one 25 h. p. engine; Schuylkill Electric Railway Co., Pottsville, Pa., one 125 h. p. engine; Durham Electric Light Co., Durham, N. C., one 80 h. p. engine and boiler; Amsterdam and Rockton Street Railway Co., Amsterdam, N. Y., one 100 h. p. tandem compound engine; Corvallis Electric Railway Co., Corvallis, Wash., one 150 h. p. tandem compound engine; Olean Electric Light Co., Olean, N. Y., one 150 h. p. tandem compound engine; Boston and Great Falls Electric Light and Power Co., Great Falls, Mont., one 150 h. p. engine; Crook, Horner & Co., Baltimore, Md., one 25 h. p. engine; Northwestern Electrical Supply Co., Tacoma, Wash., one 25 h. p. engine; E. Meyer, New York City, one 80 h. p. engine: Reading and Southwestern Street Railway Co., Reading, Pa., two 125 h. p. engines; Key West Gas and Electric Light Co., Key West, Fla., one 150 h. p. tandem compound engine, one 100 h. p. tandem compound engine, one 60 h. p. tandem compound engine, two 150 h. p. boilers, 300 h. p. Wheeler condenser, 300 h. p. Davidson air and circulating pump, 300 h. p. Davidson boiler feed pump, 300 h. p. Korting injector, etc.; Trenton Lamp Co., Trenton, N. J., one 35 h. p. engine.

THE TICONDEROGA MACHINE CO.

The Ticonderoga Machine Company, of Ticonderoga, N. Y., has recently increased its capital to $125,000, and has purchased new property in the vicinity of its old works, including a large addition to its water-power. A shop 144 x 80 feet, and a five-foot iron trunk and turbine, are now about completed. This shop i a model in convenience and equipment, and no pains or money have been spared to make it equal to any similar plant in the country. The Ticonderoga Machine Company, in addition to its other business, consisting of mining machinery, paper mill, special machines, etc., will manufacture and sell the Woodbury, Merrill, Patten and Woodbury air engine, having perfected an agreement with the patentees by which the Tincoderga Company becomes the sole licensee for New England, New York and New Jersey.

The air engine will be made a specialty, and the results now being attained in the way of economy by this engine are said to promise a large field for it.

The company has opened an office for sale of its machinery at room B, 126 Liberty street, New York, where Mr. W. B. Hammond, manager of sales department, will be pleased to attend to the wants of patrons.

ELECTRIC LIGHT IN A WESTERN QUARRY.

The firm of Dolese & Shepard, contractors and stone-quarry owners in Illinois and Wisconsin, have recently installed an arc light plant of the Thomson-Houston system at their quarry at Hawthorne Station, Ill., for the purpose of facilitating the quarrying of stone at night. Twenty-five Thomson-Houston double-carbon standard arc lamps, are used for the purpose, and are suspended from poles mounted on movable standards, so that while blasting is in progress the lamps may be moved back from the edge of the quarry pit. The firm state that since putting the plant into operation they have not only largely increased the output of their quarry, but that the men working at night turn out more stone per man than those working during the day. This is probably due to the fact that the men working at night do not suffer from the heat to so great an extent as those employed during the hours when the sun shines.

THE "CHICAGO" TROLLEY CLAMP.

Mr. John S. Gustin, purchasing agent for the Electric Merchandise Company, Chicago, after long and earnest study, has devised the "Chicago" trolley clamp, shown in Figs. 1 and 2.

The clamp is formed in three distinct parts, two sections with opposing lips, one of which is provided with a threaded projection upon which the clamping nut is screwed; the other by a dog enclosed by the protruding lower rim of the nut. Through the

Fig. 1.—"Chicago" Trolley Clamp.

lower portion of these opposing sections a groove is formed to contain the trolley wire, the size of which does not call for a different construction of the clamp. The opposing lips are cut at such an angle that they still engage each other when the largest trolley wire is inserted in the groove. The screwing down of the nut upon the threaded projection and over the dog causes the lips to slide one within the other, thus forcing together the lower sections of the clamp upon the wire, preventing all possibility of falling. The movement of the wire from expansion and contraction is provided for in the hinge joint included in the nut. With this clamp an absolutely reliable support is provided for the trolley wire, while at the same time its simple mechanism makes its adjustment, at any place upon the wire, or entire removal

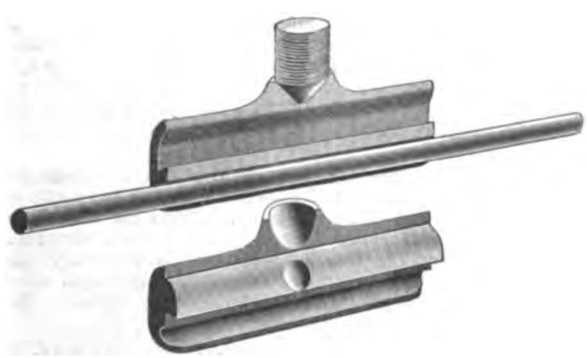


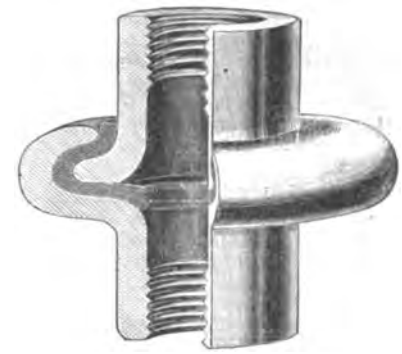
Fig. 2.—"Chicago" Trolley Clamp.

therefrom, an easy task of a minute's time. The clamp is equally efficient, whatever may be the style of insulator used in connection with it. While possessing all necessary strength, the clamp is light, and presents a neat appearance. The Electric Merchandise Company, Chicago, are sole agents for this device.

"Practical Electricity," of Boston, hitherto published as a semi-monthly has become a fortnightly, and more than ever justifies its title.

THE "PRIOR" INSULATING JOINT.

An improved insulating joint for chandeliers, where both gas and electricity are used, is illustrated in this issue, and is of special interest to those who make the wiring of stores and houses a specialty. This insulating joint was designed and is being put upon the market by Matthew Prior, of Watertown, Mass. It is made of bright brass in two castings insulated from each other by



"Prior" Insulating Joint.

the best insulating fibre, put in under a pressure of several tons and firmly held in place, thereby making the joint perfectly tight and secure from all action of gas or atmosphere. These joints are made in all the standard sizes, have no screws to twist, break off or cause short circuits, and are as strong as a solid casting. Mr. Prior is prepared to fill any and all orders from stock, and would be pleased to have our readers send to him at Box 2649, Boston, for sectional samples and all information. It has the approval of the Electrical Department of the Boston Fire Underwriters' Union.

THE "H., J. & C. CO." ELECTRICAL BLAST FURNACE.

We illustrate on this page a very simple, handy and efficient device made and sold by the Haines, Jones & Cadbury Co., of 1136 Ridge avenue, Philadelphia. The "H., J. & C. Co." electrical blast furnace is one of those things particularly useful to linemen. It is furnished, as shown, with an oblong shield attached, suitable

"H., J. & C. Co." Electrical Blast Furnace.

for their special purposes. The oblong solder pot allows the user to solder together perfectly the two ends of the wire by simply springing the wire into the pot, thereby saving much time and labor over the old way of pouring the melted solder on the joint. The apparatus is at once durable and cheap, and promises to find a wide field of popularity.

COBB VULCANITE CO.

It is understood that the party holding the mortgage on the property of the Cobb Vulcanite Co., of Wilmington, Del., has foreclosed, and that the real estate and personal property of the company will be sold at sheriff's sale on August 4.

ST. LOUIS TRADE NOTES.

THE ST. LOUIS CAR Co. are building for the Union Depot Railroad, of this city, 20 of the finest parlor street cars ever turned out in the United States. The cars are 35 feet over all in length with double trucks, a motor to each truck, and they are elegantly upholstered and fitted up. They are also engaged on an order of 130 cars for the St. Louis and Suburban Railroad, which is now being changed into an electric railway, A part of this order is being delivered. They have also just delivered a special long car to the Lindell Railway. The car is 42 feet over all, mounted on two trucks, each being supplied with a motor, and is a very handsome piece of street car work. This company has also delivered lately an order of 20 long cars for Indianapolis, also a large number of electric cars for Appleton, Wis.; Menominee, Wis.; Springfield, Ohio; Clinton, Iowa; Marquette, Mich.; Marionette, Wis.; and a lot of their well-known vestibule cars for Wichita, Kan.

THE MISSOURI ELECTRIC LIGHT AND POWER Co. are enlarging their building to twice its old size, and will put in two 5,000-light Westinghouse generators which will increase their output to 37,000 lights. The 5,000-light generator is the largest type of machine manufactured by the Westinghouse Co. The addition to the building will increase the total capacity of the station to 80,000 lights. The business of the company has increased steadily from the opening of the station some two years ago up to the the present time, the total output now being 27,000 lights. During the present summer months there has been an increased output of current due to the successful introduction of alternating current fan motors in St. Louis, and the motor business promises well for a continued output of current, owing to the fact that alternating current motors of larger power are about to be put on the market.

THE EMERSON ELECTRIC MANUFACTURING Co. have advertised for a new location East of Twentieth street. Although established only about ten months, their business has outgrown their present facilities. Their alternating current fan motor has proven a great success, and Mr. A. W. Meston, their electrical engineer, is engaged in working out plans for alternating motors of larger power for general industrial use. The Bagnall fuse switch, which has been adopted by the Lindell Railway Co., has proven successful beyond all expectations. The fuse wire always blows in the middle, leaving the clamps uninjured. This is due to the fact that the clamps do not compress or reduce the sectional area of the fuse wire. The fusing takes place quietly, leaving only a short gap between the ends of the fuse wire.

THE LACLEDE CAR COMPANY are building 10 electric cars for Duluth, Minn., and eight for Windsor, Ont. Th y have lately delivered 35 cars for electric roads in Cincinnati and Springfield, Ohio. The company is shortly to be reorganized and their capital stock increased, and they will then put on a full force of men to carry out their season's work.

THE BROWNELL CAR Co. are manufacturing the Low adjustable street car, the invention of a Californian. The car is a combination summer and winter car, which can be changed from one to the other in five minutes' time. The company are also building their well known cable and electric cars.

THE WAGNER ELECTRIC MFG. Co., 1822 and 1824 Olive street, are meeting with a very flattering demand for their alternating current motor, the sales running far ahead of their expectations. They are now engaged in perfecting motors of larger power for general use.

THE AMERICAN ELECTRIC MFG. Co. have got their incandescent lamp factory into successful operation and are turning out lamps for all purposes. They report a very flattering state of trade and inquiry for their lamps.

WESTERN TRADE NOTES.

THE POND ENGINEERING COMPANY report encouraging business from the Southwest. They are building the complete power plant for an Edison central station at El Paso, Texas; also a complete plant at Paris, Texas, for lighting and railway service. They are also furnishing Armington & Sims engines for Texarkana, Ark., and Austin, Tex.; the latter for the new Capitol building—the second engine of this make now in the Capitol.

THE ELECTRIC MERCHANDISE Co., of Chicago, the well-known dealers in street railway supplies and equipment exclusively, report business as excellent. In fact, street railway material is in very large demand all over the country, and a large number of new roads are being built, of which the Merchandise Co. with their energetic business, are obtaining a very large proportion.

MR. D. B. DEAN, traveling representative of the Electric Merchandise Co., has just returned from a trip to the Pacific coast. He has obtained numerous large orders for electric street railway supplies, and has had a highly pleasant and profitable trip.

NEW ENGLAND TRADE NOTES.

THE EASTERN ELECTRIC CABLE COMPANY, of Boston, well known as the manufacturers of the popular Clark wire, are extremely busy and do not complain at all of "dull times." This week they received one order for 50 miles of insulated wire, and they lately received the order for the whole of the cables and wire through their Western agents, the Electrical Engineering Company, of Chicago, for the incandescent wiring of the World's Fair Building in Chicago. The order calls for wires varying from the smallest single wire for incandescent purposes to cables of 500,000 circular mils. One lot has already been shipped. It may be interesting to note that the Eastern Company have built for themselves a comfortable office building, where Mr. Clark and Mr. Eustis will be pleased to see their patrons and friends. Possibly a number of our readers will remember the cosy old office with feelings of regret.

THE NATIONAL ELECTRIC COMPANY, of Boston, are enjoying a run of good business, especially with the telephone companies, in their well-known anti-induction and anti-abrasion line wires. They have now a number of lines in operation which are giving excellent anti-induction results, and the line at Revere, which is stretched on the poles of the local electric street railway company, is so perfect that whispered conversations can be distinctly heard over it. The National Company are shipping wire to New Haven, Philadelphia, Somerville, Boston and other cities for city fire-alarm and telephone purposes, and have now in contemplation a substantial increase to their factory, and will put in a number of new braiding machines.

THE RUSSELL ELECTRIC MANUFACTURING COMPANY, of Providence, has been reorganized, and has moved into its new quarters, at 212 Eddy street, of that city, with Mr. John Heathcote, treasurer, and Mr. Chas. W. Russell, manager. They are now busy manufacturing the well-known Russell mast-arm, and expect to fill contracts within the next month for about 15,000 feet. They are also bringing out a number of specialties for the electrical trade, notably a double pole arc light cut-out and an adjustable pole step, to be carried by trimmers instead of a step-ladder. The latter is made of aluminum, and weighs only three ounces, and has a spring catch which slips into the pole socket when applied.

THE WADDELL-ENTZ COMPANY have their new factory in Bridgeport all ready now for turning out work. They will go into the manufacture of dynamos and motors and storage batteries, paying special attention to electric railway work. The factory is a large and well-lighted building, and is now well equipped with machinery. Messrs. Waddell and Entz are both well known to the electrical profession, having been connected with it in varied capacities for many years, and are sure to build up a large and successful business in Bridgeport.

WARREN S. HILL, of Boston, has just brought out a neat line of single and double covered switches for incandescent work. The switches are made for branch circuits of from 1 to 25 lamps, are all mounted on porcelain bases, have the well-known Hill contact, and have plain brass or nickel covers. The price of the fifteen-ampere switch is but $2.00. With his large and varied assortment of other switches, Mr. Hill has now a very complete line of goods, and can supply a switch for almost any purpose or use in the electrical business.

A. AND J. M. ANDERSON, of Boston, well known as the manufacturers of the Anderson trolley, are placing on the market an excellent insulating material called "Ætna," which is being used extensively for bell insulators, trolley insulators, and strain insulators for electric railway work. The Buffalo street railway has a large number of them in successful use, and they are also used in Boston and Brooklyn. "Ætna" can be moulded into desired shape, is thoroughly waterproof, and will withstand an immense amount of heat.

ANNUAL CLAM BAKE.—Mr. Eugene F. Phillips, president of the American Electrical Works, of Providence, with his usual whole-souled hospitality, has sent out his invitations for the thirteenth annual Rhode Island clam dinner tendered to the electrical fraternity, to be held at the Vue de l'Eau Club, on Saturday, August 8. From past experience of these delightful meetings, we would advise every one to be present who can possibly attend. May the weather be propitious and the clams willing!

THE HART AND HEGEMANN MANUFACTURING COMPANY, manufacturers of the well-known Hart snap switch, who recently moved East from Kansas City, are now comfortably settled down in their new quarters on Pearl street, Hartford, where they have a convenient and well-equipped factory. They will continue to manufacture their regular line of goods, and are getting out a number of new specialties.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

ELECTRIC LIGHT.

Luling, Tex., is to have an electric light plant.

Tarkio, Mo., will enlarge its electric lighting plant.

Wauoo, Neb., is to have a municipal electric lighting system.

Butler, Mo., is receiving bids for a municipal electric light plant.

Chicago, Ill.—The Exposition is to be open at night, and every building will be supplied with electric lighting. Several miles of water in the lagoons and canals will also be illuminated by electric lamps sunk beneath the surface.

Union City, Pa.—A $20.000 electric light plant is to be put in by the Climax Electric Light Co., of Warren.

Beverly, Mass.—The Beverly Gas and Electric Co. has elected Hon. J. I. Baker, president; A. W. Rogers, clerk and treasurer, with a board of directors.

See further, page xii.

ELECTRIC RAILWAYS.

Lock Haven, Pa.—A company is to be organized to build an 8-mile electric railway to Mill Hall.

Lincoln, Neb.—The Lincoln Street Railway Co. now controls the street railway service of the city, which has a rapidly growing population of 70,000. Its electric plant represents a total investment of about $2,000,000, which is the capital stock of the company. The plant comprises 37½ miles of track, 100 miles of trolley wire and feeder, 80 motor cars, 40 trailers, 10 motor cars to arrive, and a fine power house with four Dick & Church compound engines of 150 h. p. each, driving four Thomson-Houston generators of 80,000 watts each. A new motor house is now being built. The rolling stock is of the Westinghouse and Short railway systems. The officers of the company are: F. W. Little, of Sioux City, president; C. J. Ernst, secretary; C. C. Upham, treasurer and general manager; E. L. Woolley, superintendent, and F. A. Webster, cashier.

Aurora, Ill., and Elgin are both ready to contribute to the proposed electric railway between the two towns.

Colorado Springs, Col.—The Rapid Transit Co. has been granted the right to lay a double track through West Colorado Springs.

See further, page xvi.

ELECTRIC LIGHT.

Shelbina, Mo.—The Royal Electric Lighting Co., of Peoria, Ill., has the contract to furnish an electric light plant for this place.

Beloit, Wis.—The Wiley-Warner Electric Lighting Co. is setting its poles. The lines will be mostly in alleys and will enter buildings at the rear.

Peru, Ind.—The electric light company has ordered a 650 light Thomson-Houston alternating current dynamo for incandescent lighting.

Waynesboro, Pa.—It is almost definitely settled that the Electric Light Co. will be granted a franchise providing the right to erect poles, etc., and with all the usual privileges.

Leavenworth, Kan.—The Merchants' Electric Light Co., recently incorporated, has elected C. M. Salinger, President; C. Hoffman, vice-president; J. H. E. Weigant, secretary, and H. Bruns, treasurer. Stock is sold in $10 shares.

Waterbury, Conn.—The Connecticut Electric Co. has elected the following officers: President, D. S. Plume; Treasurer, E. T. Turner; secretary, A. M. Young, with a full board of directors.

Chicago, Ill.—The contract for the electric light plant of the Masonic Temple has been awarded to the Western Isolated Lighting Department of the Thomson-Houston Electric Co. It will be one of the largest in the world, and will consist of six 80,000 watt generators. Between 7,000 and 8,000 lights will be wired.

TELEPHONE.

Lawrence, Mass.—The directors of the New England Telephone Co. have declared a dividend of 75 cents per share to stockholders of record at close of business July 21st.

Boston, Mass.—The decline of Bell Telephone stock to 186 is, in part, attributed to the selling of some New Bedford stockholders who were desirous of investing in Cleveland and Canton 5 per cent. gold bonds at 80, which carry a bonus of 50 per cent. in preferred stock.

TELEGRAPH.

Boston, Mass.—At the annual meeting of the Vermont and Boston Telegraph Co., Dr. Norvin Green was elected president, and R. H. Rochester, secretary and treasurer.

San Francisco, Cal.—The report of the Fire Alarm and Police Telegraph system shows that the department has now 170 miles of telegraph wire. The disbursements were $18,345, whilst the appropriation was only $18,000.

See further, page xx.

NEW BUILDINGS.

Roanoke, Va.—A residence for E. T. Burnett is to have electric work.

Boulder, Col.—An $8,000 house for Mr. Williams is to have electric lights.

Philadelphia, Pa.—St. Mary's church is to be altered and fitted with electricity.

Denver, Col.—A business house for E. W. Lowrey will be lighted by electricity. Cost, $80,000.

Pueblo, Col.—A business building for J. C. Wilson is to be lighted by electricity. Cost, $80,000.

Detroit, Mich.—An $8,000 carriage factory for Gray Bros. is to be fitted with electricity.

Philadelphia, Pa.—A club-house is to be erected on Ridge avenue and lighted by electricity.

Findlay, O.—A business house for L. D. Howes is to cost $12,000 and will have electric lighting.

Milwaukee, Wis.—A $40,000 bakery, to be erected for Johnston Bros., is to be lighted by electricity.

Windsor, Ont.—The Ever-Ready Dress Stay Co. will build a $10,000 factory and put in electric lights.

Detroit, Mich.—A warehouse for J. N. Bogley & Co. is to cost $22,000 and will be lighted by electricity.

Philadelphia, Pa.—The South Chester School Board will erect a school building and light it by electricity.

Detroit, Mich.—A building is to be erected for the Detroit Club at a cost of $50,000. It will have electric lights.

Owosso, Mich.—The First Congregational Church will erect a $25,000 building, which will have electric lighting.

Detroit, Mich.—A church is to be erected on Cass avenue. It will cost $25,000 and will be lighted by electricity.

New York, N. Y.—The wardens of St. Bartholomew will erect a $25,000 church, which will be lighted by electricity.

Madison, Wis.—The University of Wisconsin will build an armory and gymnasium, which will be lighted by electricity.

Philadelphia, Pa.—A residence for M. Gilbee and a dwelling on New street are both to be lighted by electricity.

Philadelphia, Pa.—A large mill for Clark, Thomas & Co. is to have electric lights; also a factory for Powell Bros.

New York, N. Y.—A church, to be built on 104th street and the Boulevard, will cost $50,000 and be lighted by electricity.

Wyandotte, Mich.—A trunk factory for the Beals & Selkirk Trunk Co. is to be erected at a cost of $15,000 and will have electric lighting.

ELECTRIC LIGHT.

Claremont, N. H., wants electric lights.

Toledo, O.—Plans are being drawn by N. B. Bacon for the new electric light station.

Cannelton, Ind.—Work has been commenced on the plant of the electric light and water works.

Birmingham, Conn.—One part of the electric lighting department of the Derby Gas Co. is running in perfect order.

Providence, R. I., wants to appoint a committee to investigate, with a view to establishing, a municipal electric lighting and gas plant.

Topeka, Kan.—This city has had its own lighting plant for two years, and a most exhaustive report alleges a saving as compared with Kansas City.

See further, page xxi.

TELEGRAPH.

Flint, Mich., will soon have a fire-alarm system.

Indianapolis, Ind.—The Fort Wayne District Telegraph Co. has been formed with $20,000 capital.

TELEPHONE.

Missoula, Mont.—The Telephone Exchange has made a most successful opening.

Carbondale, Pa.—It is probable that a company will be formed here to put in a Shaver telephone system.

MISCELLANEOUS.

The Equitable Electric Co. has been formed in Jersey City, with a capital stock of $250,000, to make electrical devices, etc.

The Eastern Electrical Supply Co. has been formed at Portland, Me., with a capital stock of $250,000, to make and deal in electrical supplies.

The New England Electric Brush Co. has been formed at Portland, Me., with a capital stock of $500,000, to make electric brushes under the patent of A. Stanton.

ELECTRIC RAILWAYS.

La Salle, Ill.—Through the efforts and energy of Mr. E. S. Enyart, the City Electric Railway Co. has acquired the Peru and La Salle electric railway, which connects the two cities over two separate routes. The new company has a capital stock of $125,000. The road is equipped with the Edison overhead system. W. G. Reeves, is president; F. X. Kilduff, secretary; L. B. Merrifield, treasurer and E. S. Enyart, superintendent. There are 6½ miles of track with 52 lb. Johnson rail, and 6¼ miles of No. 2 B & S. hard drawn copper trolley wire, with Simplex feeder. Guard wires will be used throughout. There are 8 cars, five double 15 h. p. motors and three open trailers, all from the St. Louis Car Co., with McGuire trucks. The power house is of brick, and is equipped with a Lane & Bodley engine of 150 h. p. and two 80 h. p. tubular boilers. Mr. Enyart writes us that they have just completed one mile of new track and are putting in a second 80 h. p. Edison generator. "The road cannot accommodate the people, and new equipments must be added." One and a half miles of extension will be added before January, 1892.

See further, page xxii.

ELECTRIC RAILWAYS.

Joliet, Ill.—Thomas Creevy and others have asked for right to build a street railroad to Lewistown. The storage-battery system is proposed.

Murphysboro, Ill.—A 120 h. p. Armington & Sims engine is to be supplied to furnish additional power for the electric street railway line.

Newtonville, Mass.—The Garden City Street Railway Co. will build an electric road between Newtonville and Newton Centre. The storage-battery system will be used.

Parsons, Kan.—The time allowed to the electric street railway has again been extended one year. As this is the third franchise allowed, the people are naturally becoming dissatisfied that nothing has yet been done.

Fort Wayne, Ind.—Workmen are employed grading the road for the railway tracks, notwithstanding the suit pending between the Land and Improvement and the Gravel Road Companies. Should it result favorably to the former, electric cars will be running before next winter.

New York City.—The Rapid-Transit Commission has taken another important step towards fulfilling its destiny by adopting resolutions concerning an East Side branch of the proposed underground railroad. The plan contemplates the piercing of a divergent tunnel from the main artery under Broadway at Fourteenth street, running thence with two double tracks, or one four-track way, to a point under Madison avenue near Ninety-sixth street, the rest of the road being carried overground to the Harlem river. This route has the double merit of directness and ease of construction. The greatest depth to the rock that underlies Manhattan Island is at Duane street, and at all other points south of Ninety-sixth street deep sewers and building foundations can be avoided without much difficulty. The preliminary work will be at once pushed.

NEW HOTELS.

West Chester, Pa.—A hotel is to be erected for J. Spence and lighted by electricity.

See further, page xxiv.

MISCELLANEOUS.

Electrical Exports.—The *American Exporter*, in its last issue, reports that the electrical exports from New York during the first six months of this year reached $369,926. The total of electrical goods for June shipped to Southern ports was 2,164 cases, valued at $80,017, or more than in any previous month. It includes a shipment of electric railway apparatus for Rio de Janeiro.

The Dr. Harm Electric Pocket Co. has been formed, to operate in Boston, New York and Chicago, with a capital stock of $200,000 to make pocket batteries.

ELECTRIC LIGHT.

Indianapolis, Ind.—Plans will soon take definite form as to the electric lighting of the city. One scheme is to buy a plant and sell it to the city on the instalment plan. The principal electric light companies will also be asked to submit figures.

Penacook, N. H.—Articles of incorporation of the Penacook Electric Lighting Co. have been filed. Capital, $10,000. The incorporators are: C. H. Sanders, E. H. Brown, G. W. Abbott, J. Whitaker, W. W. Allen, C. F. Foote, E. E. Graves, W. G. Buxton, J. C. Pearson, A. C. Alexander, I. Baty, F. A. Abbott.

Del Rio, Tex., has been lighted by electricity, and has one of the finest plants in the State.

Kansas City, Mo.—Bids are to be in by August 10 for city lighting for one year. The advertisement will call for bids for 100 or more arc lights of 2,000 c. p. each, to be located as designated by the board of public works and lighted every night of the year one-half hour after sunset and continued until one-half hour before sunrise, additional lights to be located as designated by the council upon thirty days' notice to the lighting companies.

New York City.—Residents of Thirty-second street, between Fifth and Madison avenues, have complained because the asphalt pavement in front of their homes is torn up. William H. Burke, the water purveyor, said that the Edison Company had received a permit to make some subsidiary connections in the street for the purpose of supplying houses therein, and that as soon as the work was completed the pavement would be restored by the contractor who put it down, at the expense of the Edison Company.

Missoula, Mont.—The Missoula Electric Light Co. is to install about 1,300 lights September 1, and a 150 h. p. engine. This additional plant has not yet been bought or contracted for. The existing plant is Thomson-Houston arc and alternating incandescent, and Edison direct incandescent, with 25 miles of P. & B. Candee and K. K. circuit. This plant is run by 4 Westinghouse engines and three 80 h. p. boilers. The capital stock is $50,000, fully paid in cash. Chas. Covill is president; W. A. Simons, secretary and treasurer, and H. M. Ogden, manager.

Corning, N. Y.—The Corning Gas Co. is putting in another 50-arc light dynamo. It has a capital stock of $100,000. L. C. Kingsbury is president; C. R. Cole, secretary; F. D. Kingsbury, treasurer; W. H. Christie, superintendent, and D. Gertin, assistant superintendent and engineer. The plant is combined gas and electric, the Thomson-Houston system being used. There are 18 miles of K. K. and Ansonia Brass and Copper Co. wire. The plant is run by two Rice engines of 118 and 162 h. p., with 150 h. p. boilers, built by D. M. Nichols, of New York City.

Princeton, Ill.—The Princeton Electric Light & Power Co., with a capital stock of $15,000, has recently put in a fine Thomson-Houston plant. It comprises an arc dynamo of 30 lights capacity and an incandescent machine of 650 lights. The plant is run by a 60 h. p. automatic high speed engine and a 70 h. p. boiler. Over five miles of circuit have been put up. The plant has been so arranged as to allow of an early increase. Mr. A. Sadler, of Kewanee, is the engineer, and Mr. C. C. Travis is the superintendent. The plant and the workmanship shown in its construction are highly spoken of by the *Bureau County Republican*.

See further, page xxv.

ELECTRIC LIGHT.

New Castle, O.—The New Castle Electric Light Co. has been ordered to put up more street lights or sell its plant to the town. It will probably be glad to supply street lights in any quantity for a fair consideration.

Syracuse, N. Y.—The Common Council has passed the franchise of the Onondaga Electrical Co. over the Mayor's veto.

Bristol, R. I.—About 20 25 c. p. incandescent lamps have been added by the Bristol Electric Light Co. on the Main Road, &c.

Paris, Tex., has received its electric light plant, which is being rapidly placed in position.

East St Louis, Ill.—The East St. Louis Electric Light Co. has added a new 150 h. p. engine and 2 dynamos to its plant, in order to meet demands for increased service.

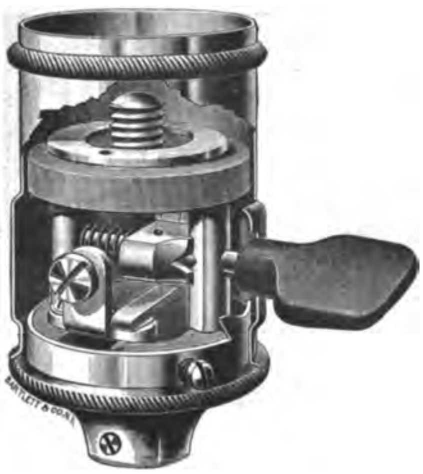
Key West, Fla.—The work of planting poles and stringing wires is being rapidly pushed forward by the Key West Gas and Electric Light Co., and the plant will soon be running.

Woodland, Cal.—Improvement is the order of the day, and the Electric Light Company is in it, so says Superintendent Dunton. A new steel boiler of 65 h. p. has just been received from the California Boiler Works, of San Francisco. Fifty feet of 30-inch smokestack was also received. The new boiler will be put in position alongside the old one, which will undergo repairs. Other improvements will probably be made.

Rochester, N. Y.—The Brush Electric Light Company, through President Mumford, has sent a communication to the Executive Board, asking permission to place underground conduits in streets, to be designated by the board, preliminary to testing devices for operating underground circuits of high tension electric currents. The company said it would be to the interest of the city as well as the company to make the tests before any particular device is adopted. The matter has been referred to the board and Superintendent Barnes.

New York City.—About 10 p. m, on Saturday, the 18th ult., the Electric Light Commission, of the city of Wheeling, W. Va., arrived in this city, for the purpose of examining its electric lighting facilities. The visiting commission consist of P. F. Farrell, chairman; A. A. Franzheim, secretary; Members of Council, P. F. Farrell, J. A. Campbell, Albert Capps, C. W. Kreiter, Chas. Craig; Board of Gas Trustees, A. J. Schultze, William H. Shafer, all of Wheeling, W. Va., and electrical engineer for commission, John A. Seely, of New York. They had with them as guests S. W. Darrah, superintendent of Wheeling city gas works; John J. Farrell, of Wheeling city gas works; W. C. Beans, city editor of *Wheeling Register*; J. W. Phoebus, of the *Wheeling Intelligencer*, and D. W. Dunn, of Pittsburgh, Pa. After visiting the different electric plants the party left for home on the evening of the 20th.

See further, page xxvi.



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English, Morse & Co.
St. Louis, Mo.:
J. H. Siegrist, Jr., & Co.
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The San Francisco Tool Co.
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ELECTRIC RAILWAYS.

Braddock, Pa.—The Braddock electric railway line has been opened successfully.

Norristown, Pa.—The Philadelphia and Reading Railroad Co. will light the new De Kalb street station with electricity.

Washington, Pa.—The new power-house is to be located at some distance from the residences, to avoid trouble from noise.

Ottawa, Ill.—Mr. A. L. Millard, of the Edison General Co., has been testing and starting a new generator for the Street Railway Co.

Hudson, N. Y.—President McGonigal, of the Hudson Electric Railway Co., states that the earnings of the railway since it has been in operation, about nine months, will exceed $11,000.

See further, page xxvii.

ELECTRIC LIGHT.

Hazelton, O., is thinking of electric lighting.

Chehalis, Wash., is now lighted by electricity.

Villisca, Ia., has voted for an electric light franchise.

Red Oak, Ia., has a franchise for an electric light plant.

Wardner, Idaho, is to have an electric light plant.

Taunton, Mass., is talking of an electric light plant.

Willamette Falls, Ore., has a 100 arc light dynamo.

Eagle Grove, Ia.—Electric lights are being talked of.

Loveland, Col., will probably have an electric light plant.

Wakefield, Mass., is thinking of having municipal electric lighting.

St. Augustine, Fla.—The Alcazar Hotel will put in a new electric light plant.

Bramwell, W. Va.—The Bramwell Electric Light Co. has put in some new machinery.

Ellicott City, Md.—An electric light plant is proposed. W. L. Nott can give information.

West Union, Ia.—An electric light plant is to be operated here by a private company.

Hastings, Mich.—The citizens have petitioned the council to erect a $13,000 electric light plant.

High Point, N. C.—A committee has been appointed to purchase an electric light plant.

Weedsport, N. Y.—The Thomson-Houston Company is putting in an electric lighting system.

Hyde Park, Mass.—J. R. Bullard has been elected a director of the Hyde Park Electric Light Co.

Winnipeg, Man.—The Royal Electric Co., of Montreal, will put in the Prince Albert electric light plant.

Niles, Mich.—The Niles Electric Co. is pushing work rapidly, and in a short time will furnish electric lights.

Wheeling, W. Va.—N. E. Whittaker and others will organize a company to operate an electric light plant.

Marion, O.—The Marion Electric Light & Power Co. has increased its capital stock from $25,000 to $40,000.

Niles, O.—The sale of $10,000 electric light bonds for building an electric light plant will take place September 1.

Waterville, Me.—The Fairfield & Waterville Electric Light & Power Co. will furnish power for the Electric Light Co.

Sioux City, Ia.—The Corn Palace is to be lighted by the Sioux City Electrical Supply Co. There will be over 3,000 lights.

Schuylkill Haven, Pa.—The Thomson-Houston company has the contract for furnishing an electric lighting plant for this place.

Pittsburgh, Pa.—The large Ferguson Building is to be wired by the Edison General Co. for 900 lights. The "interior conduit" system is to be used.

Elmira, N. Y.—The Elmira Illuminating Co has elected P. K. Kobbe, of New York, president; F. A. Cheney, of Elmira, secretary and treasurer.

Schenectady, N. Y.—Bids for lighting are to be put in, and it is expected that the struggle will be a lively one between the gas company and other interests.

Quincy, Ill.—The total cash value of the Thomson-Houston electric light plant is placed at $105,000. The city will probably pay $90 per light monthly, and put in a smaller plant.

Southbridge, Mass.—The Southbridge Gas & Electric Co. has elected H. C. Wells, president; C. W. Johnson, treasurer; E. P. Wells, clerk. A most gratifying report was made.

Sharpsville, O.—The Electric Light Co. has made a proposition to furnish 10 or more lights of 2,000 c. p. for $85 each a year. The lighting committee offer in return to take 12 lights at $75.

Old Town, Me.—A contract is to be made with the electric light company for 28 incandescent street lights for the villages of Old Town, Upper Stillwater and Greatworks, until April, 1892.

See further, page xxviii.

Kettle Falls, N. Y.—The capital stock of the Kettle Falls Light & Power Co., recently organised, is $100,000; all the incorporators are Rochester men: G. H. Smith, A. A. Davis, J. H. Richards and others.

Portland, Conn.—The electric light plant will probably be ready to begin operations by November. The river will probably furnish the water-power required, which will also serve to run street cars within a year.

St. Paul Minn.—Mr. T. Lowry has a plan for placing arc electric lights on every side of the block on which his arcade building is situated. The St. Paul Light, Heat & Power Co. asks permission to lay subways in the streets and alleys.

St. Cloud, Minn.—Bids for putting an electric light plant in the Minnesota State Reformatory have been received by D. E. Myers, the superintendent. The plant to be of 4,000 lights, with accessories of chandeliers, pulleys, &c.

Oakland, Cal.—A contract has been made between the board of trustees and Mr. Osborne whereby he is to receive a salary of $150 monthly for which he is to light the town, he having the privilege of supplying incandescent light to private customers.

Paxton, Ill.—The Electric Light Co. has entered into an agreement with the city to operate the water works for $60 per month, and will furnish 18 large street lamps at $7.25 each per month. The company earns a profit of 10 per cent. on its $24,000 capital.

Orange, N. J.—The Essex County Electric Co. will put in a large and improved plant to furnish light for Orange. It will erect a fine fireproof building, and will have two 300-h. p. Corliss engines, six 100-h. p. Ball engines and 32 dynamos. The capacity will be 1,440 arc, or 16,000 incandescent lights. The cost will be about $50,000.

San Francisco, Cal.—The California Electric Light Co. has been authorized to change some of its lights, and to place 25 arc lights of 2,000 h. p. on poles 40 feet high in certain places. A proposition to form a new company in conjunction with the Edison system was unanimously approved. P. B. Cornwall is president; G. Sutro, vice-president, G. R. Roe, secretary.

Ottawa, Can.—On July 28, J. R. Arnold, chief mechanical engineer of the Public Works Department, admitted, before the public accounts committee, receiving bribes from two Montreal firms doing a large Government business. The agent for the Edison Company, whose light is in use in the Government buildings, had sent him a present from New York, but he had not accepted it as a bribe. The agents of the United States Electric Light Company had, he said, tried to buy him, but had failed.

See further page xxx.

ELECTRIC RAILWAYS.

Tacoma, Wash.—Ten new electric cars have been ordered from the Pullman Company.

Baldwinsville, N. Y.—The people here are hoping for an electric line soon from Syracuse.

Haywards, Cal.—Subscriptions for the Haywards Electric Railroad bonus continue to come in. Already $3,225 have been subscribed.

Niles, O.—The ordinance granting the Trumbull Electric Railway Co. the right to construct and operate a railway is under discussion.

Marion, Ind.—There is a project to extend the Marion Electric Street Railway to Jonesboro, which gives great satisfaction to the latter place.

Pittsburgh, Pa.—The Pittsburgh and Birmingham electric road employees have recently had a raise in wages, but say they are willing to take less for shorter hours.

Spokane Falls, Wash.—Four more electric cars have arrived and the entire number will soon be here and in operation, after which horse cars will be a thing of the past.

Asheville, N. C.—The electric street car lines work admirably, and are regarded as a great institution. The 4-mile track to Sulphur Springs will soon be in operation.

Pittsburgh, Pa.—Sliding trolleys are being put on the cars of the Pittsburgh and Birmingham Traction Co. All the other lines in Pittsburgh use the underrunning wheel trolley.

Wilkesbarre, Pa.—The Wyoming Valley Traction Co. has adopted the Short gearless motors for its electric road, and its 18 new cars will be equipped with that type of motor.

Athens, Ga.—Manager Voss reports that in spite of the burning out of the generator armature, the road will get down to business again at once. Two new cars will also be put in operation, making 4 on the road.

Oakland, Cal.—J. W. Hearst is interested in a proposed long electric road for which a franchise has been petitioned. He is a nephew of the late Senator, whose widow is said to be back of the enterprise.

Kansas City, Kan.—A statement has been made by Colonel Edgerton that as soon as a franchise can be obtained the company will take its "L" trains off some part of its line and substitute electricity as a motive power.

Vincennes, Ind.—A Chicago firm has contracted to furnish the Vincennes Street Railway Co. with the Westinghouse trolley electric system. A power-house will be erected at once. The contract calls for four 20 h. p. single reduction motors.

Worcester, Mass.—A new street railway company has been organized by C. S. Turner, J. M. Drennan, G. A. Stevens, H. H. Bigelow, J. H. Clarke, I. E. & L. Bigelow. The name will be the Worcester & Shrewsbury Street Railway Co. The capital is $20,000, divided in 200 shares of $100 each.

See further, page xxxi.

ELECTRIC RAILWAYS.

Madison, Wis.—The Madison Elevated Electric Railway has been formed with $10,000,000 capital.

Whitinsville, Mass.—The proposed electric railway will connect this place with Manchaug, East Douglas, Douglas, Uxbridge, and probably Millville. A six-mile branch would connect it with Mendon and the Milford and Hopedale road.

Seattle, Wash.—An electric line is to be built from this place to Puyallup by F. E. Sander, L. H. Griffith, and others. The line will be 32 miles long, and will cost $400,000. It will connect with the Tacoma and Puyallup Electric Line, making a continuous line between Seattle and Tacoma.

Paterson, N. J.—The Paterson Railway Co. proposes to raise funds for improvements in the adoption of the electric overhead system, and will execute a mortgage for $1,250,000. The entire system will be reconstructed, and a contract for the work has already been awarded to the Field Engineering Co. of New York City.

New York City.—Judge Coxe, of the United States Circuit Court, having decided that the Brush Electric Company is entitled to the control in this county of the manufacture and sale of electric storage batteries, it is understood that the running of storage-battery cars will be resumed on the Fourth and Madison Avenue street-car lines.

Santa Cruz, Cal.—The Santa Cruz, Garfield Park and Capitola Electric Railway, capital stock, $100,000, has a Thomson-Houston plant of the overhead system. It has 8 miles of 40 lb. track, and contemplates building 8 miles. It has 6 miles of Roebling circuit. Guard wires will be used in part. There are 4 motor cars and 4 trailers, the cars being built by Holt Bros., of Stockton, Cal. More cars are to be added. The plant is run by a Fraser-Chalmers Corliss engine of 250 h. p., and a Taylor-Beck of 85 h. p. The power-house is of wood and insured. J. H. Logan is president; E. H. Robinson, vice-president; Bank of Santa Cruz Co., treasurer, and F. W. Swanton, secretary.

Windsor, Ont.—The Sandwich, Windsor and Amherstburg Electric Railway Co. are going in for a number of improvements. Their capital stock is $200,000, and they have $100,000 bonds not yet sold. J. M. Clark is president; C. E. Warner, treasurer, and W. C. Turner, general manager. The company has the Westinghouse overhead system with 6 miles of track, and 6 miles of No. 0 Roebling wire circuit. No guard wires are used. There are 10 cars equipped, built by the Laclede Car Co., with Brill trucks. The plant is run by a Brown engine of 200 h. p. capacity. The power-house, of stone and iron, cost $12,000. The company has a 14-mile extension in mind to Amherstburg, and has been thinking of operating it by steam direct. It also proposes to put in a plant of 1,000 incandescent lights. It is to add 10 new cars to its rolling stock.

See further, page xxxii.

ELECTRIC LIGHT.

Hammond, Ind., is thinking of electric lights.

Dixfield, Me.—Electric lights will soon be started again.

Centerville, Ia.—An incandescent electric light system is to be put in.

Cœur d'Alene, Wash.—The Edison General Electric Co. has contracted to put in a 700-light plant. W. L. Gleason is manager.

Madison, Me.—A system of electric lighting is to be put in the village and at the pulp mill, by the Thomson-Houston Electric Light Co.

Ellenville, N. Y.—Lyman Russell succeeds his father as bookkeeper for the tanning company, and will give his attention to the electric light business.

Milwaukee, Wis.—The Milwaukee Power & Lighting Company has been granted equal rights with the other lighting companies, despite strong opposition.

Pittsfield, Mass.—The local electric light company has elected Alex. Kennedy, president; W. A. Whittlesey, treasurer; W. L. Adams, clerk. The report for the last six months is most satisfactory.

Hoboken, N. J.—The D., L. & W. Railroad Co., through its electrician, P. H. Brangs, is putting in a large combination plant for generating electricity, gas and steam. The electric light room will be 40x40 feet; the boiler house will be 40x65 feet and will contain eight 100 h. p. boilers from the Stearns Mfg. Co., of Erie, Pa. Mr. Brangs, will install a plant first-class in engineering and in every item of construction.

Salt Lake City, Utah.—The Salt Lake Power, Light and Heating Co. is to put in two new Armington & Sims engines of 100 h. p. The plant is Thomson-Houston, Western Electric and Edison incandescent and arc. There are about 200 miles of circuit of various makes. The plant is run by 400 h. p. Buckeye engines, 600 h. p. Armington & Sims, and 65 h. p. Westinghouse. Frank H. Dyer is president and James Moffatt, secretary.

See further, page xxxiii.

MISCELLANEOUS.

Chicago, Ill.—The Electrical Reminder Co. has filed an increase of stock from $25,000 to $250,000.

Denver, Col.—A new ordinance provides that all electricians and those engaged in the business of wiring shall pay a yearly license and file a $2,000 bond.

Boston, Mass.—Everything is now ready for operating the Federal street drawbridge by electricity. The bridge will be run by a Thomson-Houston 22 h. p. motor.

The Baehr Electric Mfg. Co., of Newark, N. J., has been formed with a capital stock of $50,000 to make and handle electrical appliances.

The Welsh-Edison Suit.—E. Baker Welsh, who sued T. A. Edison for $250,000 for breach of contract, has been ordered by Judge Nelson of the United States Circuit Court to produce certain letters within thirty days and also file a bill of particulars setting forth in what patents, inventions, etc., he claims to have an interest.

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OF

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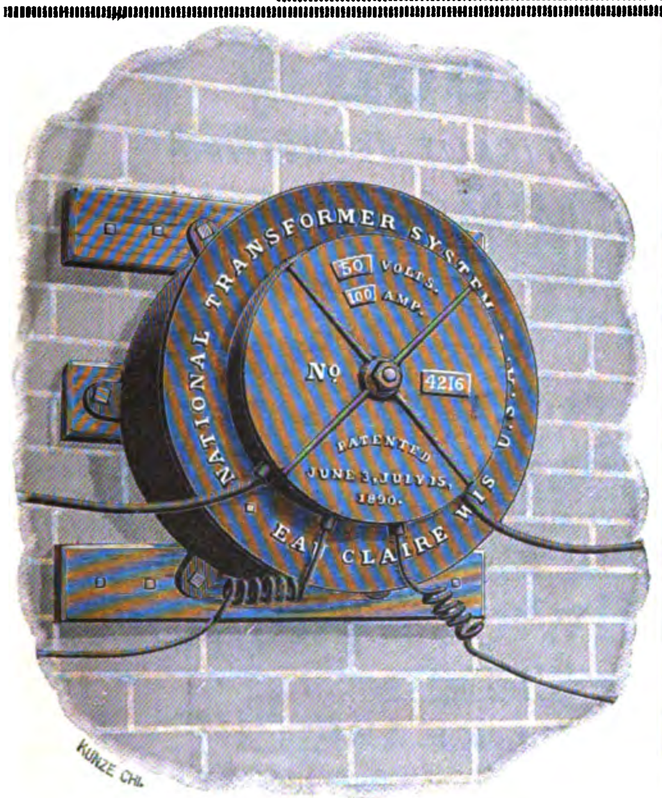

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Cincinnati, O.—W. N. GRAY, 12 Chamber of Commerce.
Washington, D. C.—L. N. COX, 16 Fifth Street, S. E.
Philadelphia, Pa.—C. M. BLANCHARD, Girard Building.
St. Paul, Minn.—THE ELECTRICAL ENGINEERING AND SUPPLY CO.
Detroit, Mich.—COMMERCIAL ELECTRIC CO.
Denver, Col.—THE MOUNTAIN ELECTRIC CO.
Winnipeg, Man.—SIMPSON-DAVIS ELECTRICAL CONSTRUCTION CO.
San Francisco, Cal.—NATIONAL ELECTRIC DEVELOPMENT CO.
Lincoln, Neb.—LINCOLN ELECTRICAL MFG. AND SUPPLY CO.
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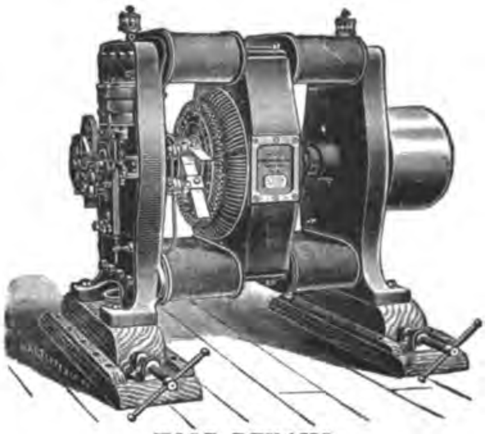

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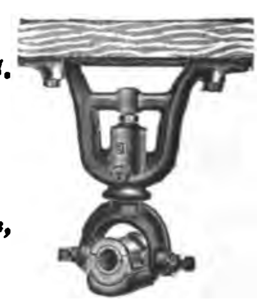

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THE
Electrical Engineer.

VOL. XII. AUGUST 12 1891. No. 171.

THE MANCHESTER SQUARE, LONDON, ALTERNATING CURRENT STATION.

ALTHOUGH London had for a long time labored under the reproach of tardiness in the adoption of the electric light, the progress which has been made during the last year or two gives sufficient indication of the fact that before long the capacity of its stations will exceed considerably that of like plants in any other city in the world. Situated in the majority of cases right at the centre of densely populated districts, these stations have found a ready demand for current, and capital has now been easily found for the erection of large and excellently equipped plants.

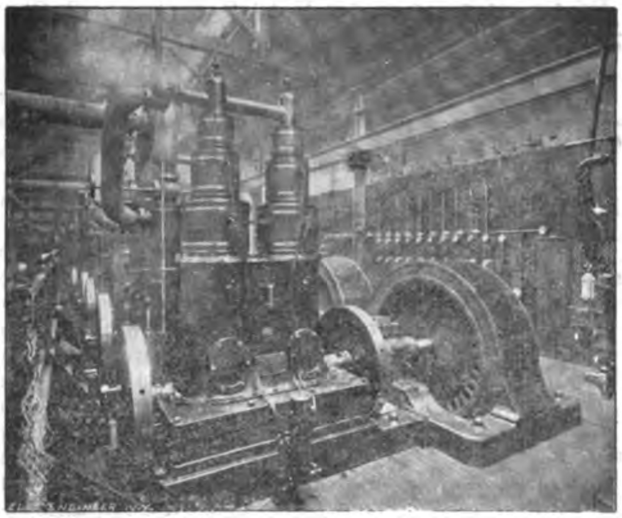


FIG. 1.—MAIN DYNAMO ROOM, MANCHESTER SQUARE STATION, LONDON.

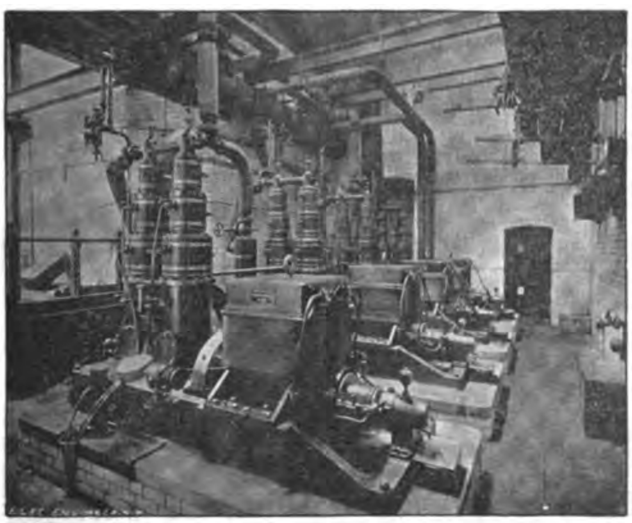


FIG. 2.—EXCITERS, MANCHESTER SQUARE STATION, LONDON.

The most recent addition to these is the alternating station of the Metropolitan Electrical Supply Co., situated at Manchester Square, which has been equipped throughout by the Electric Construction Corporation, Limited, of London, whose works are situated at Wolverhampton.

The plant consists of nine 160 h. p. Babcock & Wilcox boilers, with duplicate pumps and feed-water arrangements throughout; 10 Willans & Robinson double triple-expansion, central-valve, high-speed engines, each capable of indicating 200 h. p. at 350 revolutions per minute, each of these being coupled direct to an Elwell-Parker alternating-current machine mounted upon a common bed-plate with the engine, as shown in Fig. 1, and giving an output of 1,000 volts and 100 amperes. In addition there are four 50 h. p. engines, running at 450 revolutions, driving four Elwell-Parker shunt-wound dynamos as exciters, Fig. 2, any two being capable of exciting the whole number of alternators in the station. The steam pipes are arranged so that there is a duplicate feed to every engine.

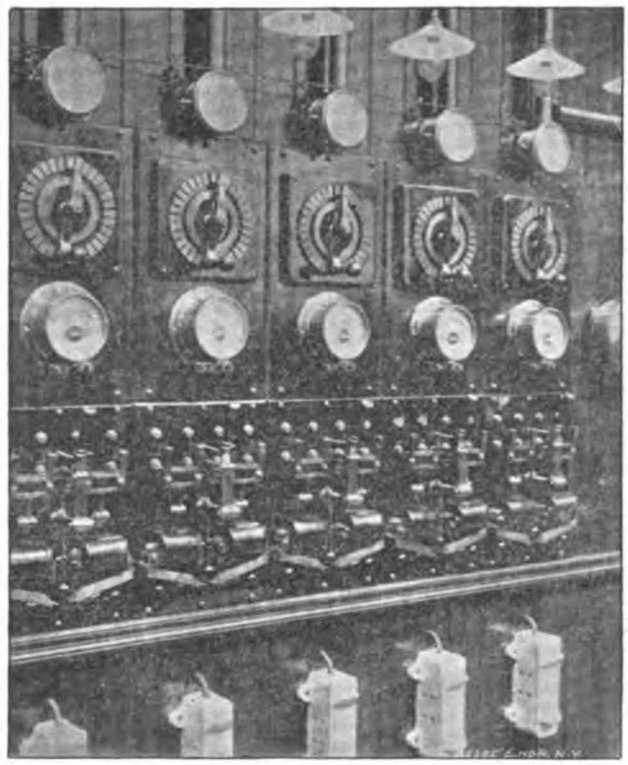


FIG. 3.—SECTION OF MAIN SWITCH BOARD, SHOWING DOUBLE-POLE AUTOMATIC CUT-OUTS, ETC., MANCHESTER SQUARE STATION, LONDON.

A new feature of the main switchboard consists in the employment of double-pole automatic magnetic cut-outs in place of fuses. These cut-outs, which are shown in Fig. 3, have given most satisfactory results; they can be set exactly to go off within one or two per cent. of the determined amount of current. One of these is fixed in each dynamo circuit.

There are 22 circuit switchboards, a section of one being shown in Fig. 4, arranged so that any dynamo can be connected on to one or all of the circuits. Trunk mains are also brought into the station from other stations of the

Metropolitan Company, so that when there is only a light load, and in case of necessity, the Manchester Square station may be stopped entirely, its load being taken by one of the other stations. This is found of great advantage in the summer months, when only light loads are required, one station supplying the whole of their system

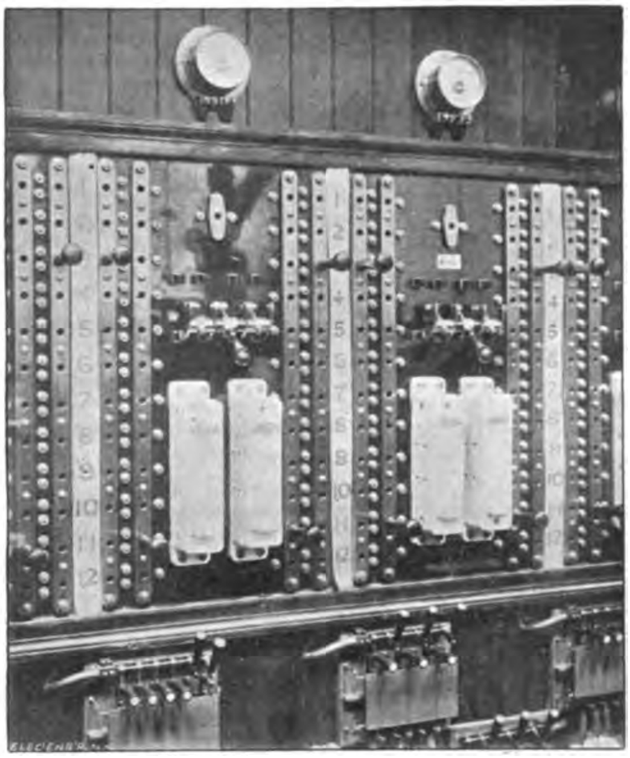


FIG. 4.—SECTION OF CIRCUIT SWITCH BOARD, MANCHESTER SQUARE STATION, LONDON.

excepting during a few hours in the day. The transformers used in conjunction with this station are of the ordinary Elwell-Parker pattern.

THE PHOTOGENIC EFFICIENCY OF VARIOUS SOURCES OF LIGHT.

In a recent communication to the Académie des Sciences, M. Witz gives the following figures relating to the comparative photogenic efficiency of the various sources of light.

Sources of Light.	Expenditure.	Calories transformed.	Intensity in carcels.	Calories per carcel-hour.
Stearine candl.	10.5 grammes per hour...	110	$\frac{1}{6.5}$	716
Ordinary gas-burner.....	105 litres per hour.	567	1	567
Regenerative lamp	35 litres per hour.........	189	1	189
Glow lamp.....	3.5 watts per candle.....	3.1	$\frac{1}{6.5}$	20
Arc lamp......	4.5 watts per carcel	4	1	4

If we take the arc lamp as our standard, the comparative efficiencies are as follows: Arc lamp, 100; glow lamp, 20; regenerative gas-burner, 2.1; ordinary gas-burner, .7; stearine candle, .56.

THE ELECTRO-DEPOSITION OF ZINC AND ALUMINUM.

The following recipe for an electrolytic bath is given by Kaselowsky, of Berlin:

Sulphate of zinc.................	10 kilogrammes.
Glucose.........................	5 "
Water...........................	100 litres.
Sulphate of aluminum...........	200 grammes.

Weak, but constant, currents must be employed, and the strength of the bath must be kept up by the addition of fresh quantities of the soluble salts of zinc and aluminum. Kaselowsky has also obtained good results from a bath composed as follows:—

Chloride of zinc.................	6 kilogrammes.
Glucose.........................	5 "
Water...................... ..	100 litres.
Chloride of aluminum............	350 grammes.

AN AERIAL WIRE VIEW IN ADELAIDE, S. A.

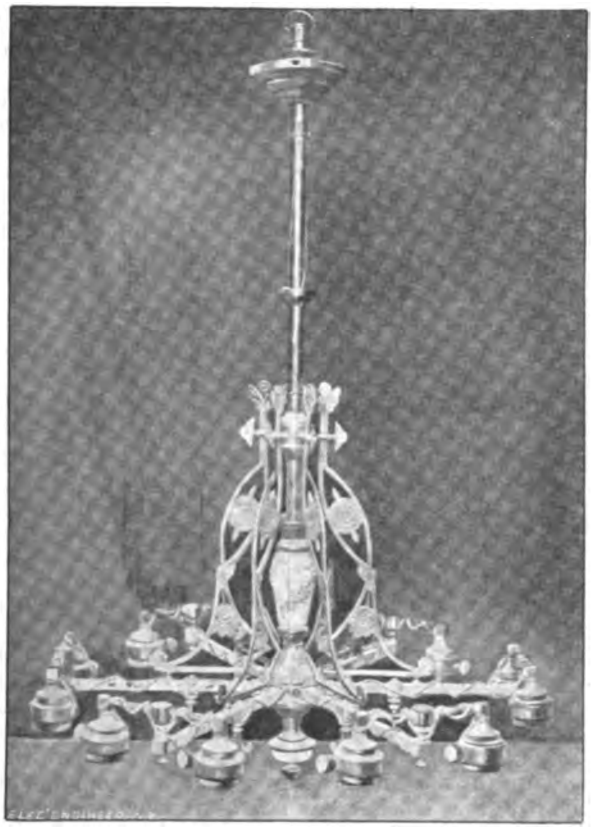
It is stated that the agitation for underground wires has spread to Australia, and that one of the first results is the proposition to give the city of Melbourne a complete underground system. Data are now being collected for the purpose, and a board of expert engineers is to give the matter immediate attention. As a general thing, however, street wiring in Australia has been above the average, and the view which we present here from King William street, Adelaide, South Australia, gives a fair idea of the manner in which work is done in that part of the world. The use of wood is avoided, one reason probably being the scarcity of big timber for the purpose, and another the fact that with such exposure to the climate the poles would not last long. The poles shown are of iron, in sections, and reach a height of about 40 feet. Those in the view are restricted to telegraph and telephone work, and carry about 150 wires. It will be observed that in some instances the cross-arms are, so to speak, made into simple brackets, and are carried on one side of the pole. This is due to the frequent occurrence of awnings and balconies across the sidewalk for shade, the arms being turned out so as to clear them. As will be seen, the

OVERHEAD WIRES IN ADELAIDE, S. A.

work is neat and trim throughout, and does little to detract from the beauty of the thoroughfare, adding rather to the air of life and bustle that one would expect in the leading business street of a new and growing city. We are indebted for the photograph to Mr. Lee L. Murray, electrical engineer, of Melbourne, Victoria.

THE FIRST INCANDESCENT CHANDELIER.

HE chandelier of which an illustration is shown on this page is one of the most interesting relics of the early days of incandescent electric lighting. It is, in a word, the first chandelier ever used for the specific purpose of carrying incandescent lamps. It was in use at the residence of Mr. Francis R. Upton, at Menlo Park, near the laboratory where all the experimental work in connection with the Edison lamp was done; and was put up during 1880. This fixture was purchased from Mitchell, Vance & Co. originally, and then wired on the spot in a manner that indicates more than anything else the crudeness and difficulties of pioneer practice. It will be noticed that the wire runs exteriorly around the stem of the chandelier and the branching arms. Moreover, great care was taken to distinguish the polarity of the two sides of the circuit, the positive wires being of red "flexible cord" and the negative of blue. Another observable point is that the lamps were burned in the inverted position now so familiar, but then so entirely new and novel. The initial letter of this article shows one of the arms with sockets attached. The lamps that were in the sockets when the chandelier was first used have been preserved also, and are of the early Edison make in which platinum clamps were employed for holding the carbon filaments.



THE FIRST INCANDESCENT LIGHTING CHANDELIER.

This chandelier is now in the possession of Mr. Luther Stieringer, of this city, to whom it was presented by Mr. Upton, and to whom we are indebted for the opportunity of making the present cuts of it. Mr. Stieringer, by the way, has made a large collection of such interesting and valuable mementoes and relics, and hopes the day is not far distant when the electrical community will have provided some fireproof place of deposit for them—a museum of the electrical arts and sciences. He and others of like tastes are in possession of enough material for a collection and exhibit second to none of its class for interest and importance.

ELECTRIC LIGHTING OF RAILROAD CARS.

BY

J. D. Dallas

PERHAPS it may not be generally known to what an extent the development of the electric light has been applied to the lighting of trains. With the idea that a short account might be of some interest, the writer will proceed to give a brief description.

The two principal methods of lighting trains are:

1. By storage batteries, the charging of the cells being performed at each terminus.

2. By storage batteries as auxiliary to a dynamo operated by steam on the train.

The second method is the one more generally adopted. Each car has a certain number of cells connected to a dynamo in such a manner that each set of cells is equidistant from the dynamo, and each, consequently, receives the same amount of charge. Every car is also a complete unit in itself, so that should any one car be detached at a way station, the continuity of the circuit is still complete; at the same time the car thus detached is provided with the power to operate the lamps.

The method of obtaining this end is shown in the accompanying diagram, Fig. 1, three cars alone being shown for convenience. From the dynamo D one main is run the whole length of the train and back again to one terminal of the battery nearest the charging dynamo, and from the other pole of the machine the return main is run the length of the train merely. Connection between successive cars is accomplished by couplers. These connections usually are placed under the roof of the car over the platform. At the end of the train furthest from the dynamo a jumper is employed, completing the circuits A_1 and A_2.

Supposing that each car be of the same length, the distance from the dynamo to each battery is the same, or, in other words, each battery is equidistant from the source of power. Given that each battery be of the same counter-electromotive force and resistance, each will receive an equal amount of charge. The lamp circuit is, of course, distinct from the charging circuit, so that should any one battery become charged sooner than the others the circuit may be opened and the charging stopped on this particular battery, and thus the circuit for charging the other batteries is not disturbed.

A detail of the connections is shown in the diagram, Fig. 2. By opening the switch the charging circuit is broken. A is a switch for regulating the discharge of a greater or lesser number of cells; the other connections can easily be traced.

Having thus described the circuits generally, it will be well to consider the method of operating the dynamo. The ideal source of power, of course, would be by the transmission of the power from the axle. However, as this has been so far, in this country, impracticable on account of mechanical reasons, steam taken from the locomotive is usually employed. The Pullman Palace Car Co. operate many trains in this way, such as those running from Jersey City to Chicago over the Pennsylvania road; the Florida special, running between Jacksonville, Fla., and Jersey City, in winter; the Montezuma special, the Golden Gate express, etc., all solid vestibuled trains. The dynamos are coupled directly to engines of the Brotherhood type, running at a speed of four hundred revolutions per minute. The dynamos are of the Eickemeyer ironclad type, suitable for slow speeds; they are shunt-wound machines. There is, of course, a suitable means of regulating the charging with an automatic switch in circuit to prevent the running of the dynamo as a motor, should any accident occur to the engine, or by reason of steam-supply becoming inoperative.

A solid train, for example, leaving Chicago at 5.30 p.m., during six months of the year would require all the lamps to be lit when the train started; this load would continue, with the exception of the lights on the dining car, till 11 p.m. At this hour all but two lamps and vestibule lights are extinguished. During this time the dynamo and battery have been running in conjunction, part of the load being taken by the dynamo and part by the batteries. By 11 o'clock they have become partly exhausted of their charge, which is replenished during the night, and when complete the engine is shut down. The batteries then run the lights in cupboards, etc., during the day and when going through tunnels; also for operating the fan motors for exhausting and replenishing the air in the cars; so that when the train arrives at Jersey City on the following evening the batteries are fully charged, ready to commence the return journey in the morning to Chicago, at which place the train again arrives on the third from the time of its departure.

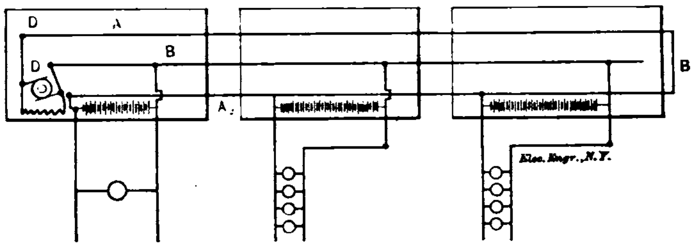


FIG. 1.—ELECTRIC TRAIN LIGHTING.

In conjunction with the operation of an electric plant on the cars the heating of the train is also accomplished. Connections are made so that this end may be obtained in three ways:

1. By heating the train from the exhaust steam. 2. By the heating of the train by a reducing valve on the steam-supply pipe and running the engine at the same time; or, 3. Should the engine not be in operation the heating by steam from the locomotive can still be carried out. The patent for this method is held by the Pullman Co. The method of lighting cars by batteries charged at each terminus is employed to a greater or less extent by the Burlington, Cedar Rapids and Northern R. R. and other roads. The Chicago, Milwaukee and St. Paul light two or more of their solid trains running between Chicago and St. Paul, and between Chicago and Omaha. In these cases a separate car is employed, with engine, boiler and dynamo, all complete, the water being stored in a tank beneath the floor. There are other roads employing electrical methods of illuminating their cars, such as the Intercolonial, of Canada. Many forms of storage batteries are, and have been, employed, such as the Julien, Brush, etc., the one adopted by the Pullman Co. being the type known as the Faure-Sellon-Volckmar, manufactured by the Accumulator Co.

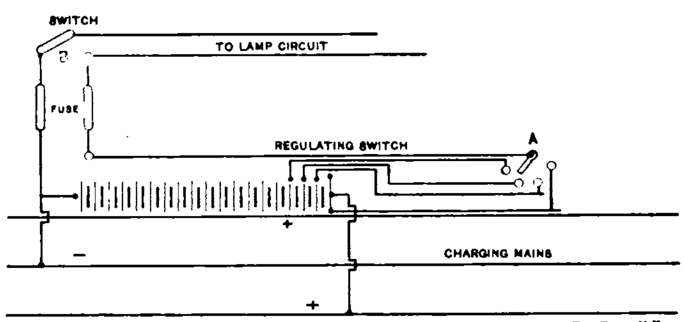


FIG. 2.—ELECTRIC TRAIN LIGHTING.

As to the cost, it may be briefly stated that for solid trains, running long distances, the electrical is a more economical than the old oil method of illumination.

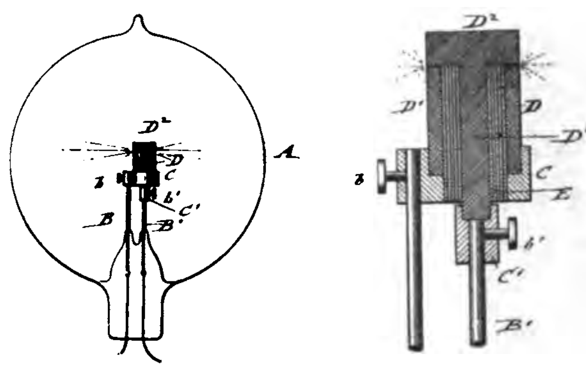
Considering that the deadly car stove has been superseded by steam-heaters, it is a source of wonder that the public do not insist on a better method of illumination than oil. Perhaps more human beings have met their deaths from fire in cars caused by lamps than by heaters.

Light in cars at night is an essential all the year round; on the other hand, for a considerable portion of the year heaters are unused. Nevertheless, in the height of summer every railroad wreck, when burnt, is attributed to the heater. The writer is, of course, aware that the locomotive is a source of many of the fires at wrecks, and would add that the oil in such cases yields an efficient aid to the kindling process.

THE WERTZ ARC LAMP.

THE operating mechanism for feeding the carbons, although more or less complicated, has always been considered a *sine qua non* of the arc lamp, and the efforts of inventors have hitherto been directed towards simplifying, rather than abolishing, it.

Recently, however, Mr. Xavier Wertz, of this city, has, by an ingenious combination of the principles of arc and incandescent lighting, invented a lamp in which the arc


WERTZ ARC LAMP.

is placed in a vacuum, the carbons being consumed so slowly that no feeding device is required.

In the accompanying illustrations, Fig. 1 shows the lamp itself, while Fig. 2 is an enlarged view of the carbons and leading-in wires. As will be seen, A represents a glass globe, the air being exhausted after the conducting-wires have been sealed into the neck. The conducting-wires B B′ pass through the neck into the interior of the lamp and are attached by the clamp-screws *b b′* to the cup-shaped sockets C C′, which serve to support the inner and outer carbon pencils D D′, by the contact of which the arc is obtained. The outer carbon D is cylindrical and is supported in the cup-shaped socket C. The inner carbon D′ is made with a cylindrical shank having an enlarged head, D², which rests on the upper edge of the outer cylindrical carbon. The space between the shank of the inner carbon D′ and the tubular outer carbon D is filled with an insulating layer, E, of asbestos, which prevents the current from passing from one carbon to the other, except at the contact faces. The shank of the inner carbon D′ is in contact with the conducting-wire B′ and supporting socket C. The sockets C C′ are made of metal, and serve to conduct the current to the outer and inner carbons.

At the point of contact of the upper edge of the outer carbon with the head of the inner carbon an arc is formed which is of sufficient size to produce a light of considerable power.

This lamp is intended for high-tension currents, and may be used in circuit with the ordinary arc lamps now in use.

A HANDY WIRING TABLE.

BY

N. R. Leyden

THIS table is arranged to show the size of wire for all the various low potentials and percentages of loss used in practical electric lighting and for 500-volt motor and electric railway circuits. It is calculated on the assumption that the conductivity of commercial copper wire is .97 of the conductivity of pure copper, according to the Matthiessen standard. It is also assumed that the cross-section of wire doubles with every three sizes of Brown & Sharpe gauge, which, though not absolutely correct, is sufficiently accurate for practical work. The safe-carrying capacity is taken as four-tenths of the current required to heat underwriter's insulated wire to 212° Fahrenheit in air, or seven-tenths of the current required to bring it to the same temperature when placed in moulding.

The manipulation of the table is very simple; for example, suppose we wish to carry 40 amperes 300 feet from the centre of distribution at 100 volts and 5 per cent. loss. From "40" in the column for "300 feet" cross laterally to the column headed "5 per cent. loss" at "100 volts," and we have the size of conductor as No. 3 B. & S. gauge.

The table is calculated for even percentages of loss at 100 volts. For 110 and 220 volts the percentages are fractional, but, by taking the nearest fractional percentage below the required one, the error is always on the safe side. For example, suppose we wish to carry 10 amperes 75 feet at 110 volts and 2 per cent. loss. From "10" in the column for "75 feet" cross to the column headed "1.8 per cent. loss" at "110 volts," and we have No. 11 B. & S.

FIGURES AT TOP OF COLUMN: DISTANCE IN FEET FROM CENTRE OF DISTRIBUTION. CURRENT IN AMPERES GIVEN BELOW.

	.2	.4	.5	.63	.8	1.	1.3	1 6	2.	% Loss at 500 Volts.													
	.45	.9	1.13	1.43	1.8	2.27	2.86	3.6	4.54	% Loss at 220 Volts.													
.25	.5	1.	1 25	1.57	2.	2 5	3.15	4.	5.	% Loss at 200 Volts.													
.45	.9	1.8	2.27	2.86	3.6	4.54	5 7	7.3	9.1	% Loss at 110 Volts.													
.5	1.	2.	2.5	3.15	4.	5.	6.3	8.	10.	% Loss at 100 Volts.													
1.	2.	4	5.	6 3	8.	10.	12.6	16.	20.	% Loss at 50 Volts.													
										25	50	75	100	150	200	300	400	500	600	700	800	900	1000
10	13	16								9	5	3	2	1									
9	12	15	16			Size of Wire				12	6	4	3	2	1								
8	11	14	15	16		B. & S. Gauge				15	8	5	4	3	2								
7	10	13	14	15	16					19	10	6	5	3	2	1							
6	9	12	13	14	15	16				24	12	8	6	4	3	2	1						
5	8	11	12	13	14	15	16			31	15	10	8	5	4	2	2	1					
4	7	10	11	12	13	14	15	16		38	19	13	10	6	5	3	2	2	1				
3	6	9	10	11	12	13	14	15	16	49	24	16	12	8	6	4	3	2	2	1	1		
2	5	8	9	10	11	12	13	14	15	62	31	20	15	10	8	5	4	3	2	2	2	1	1
1	4	7	8	9	10	11	12	13	14	77	38	26	19	13	10	6	5	4	3	2	2	2	2
0	3	6	7	8	9	10	11	12	13	97	49	32	24	16	12	8	6	5	4	3	3	3	2
00	2	5	6	7	8	9	10	11	12	123	62	40	31	20	15	10	8	7	5	4	4	3	3
000	1	4	5	6	7	8	9	10	11	154	77	52	38	26	19	13	10	8	6	5	5	4	4
0000	0	3	4	5	6	7	8	9	10	195	97	65	49	32	24	16	12	10	8	7	6	6	5
	00	2	3	4	5	6	7	8	9		123	82	62	40	31	20	15	14	10	9	8	7	6
	000	1	2	3	4	5	6	7	8		154	104	77	52	38	26	19	16	13	11	10	8	8
	0000	0	1	2	3	4	5	6	7		195	130	97	65	49	32	24	20	16	14	12	11	10
		00	0	1	2	3	4	5	6			164	123	82	62	40	31	25	20	18	15	14	12
		000	00	0	1	2	3	4	5			208	154	104	77	52	38	31	26	22	19	17	15
		0000	000	00	0	1	2	3	4			220	195	130	97	65	49	39	32	28	24	22	19
			0000	000	00	0	1	2	3				220	164	123	82	62	49	40	35	31	27	24
				0000	000	00	0	1	2					208	154	104	77	62	52	44	38	34	31
					0000	000	00	0	1					220	195	130	97	78	65	56	49	43	39
						0000	000	00	0						220	164	123	98	82	70	62	54	49
							0000	000	00							208	154	123	104	88	77	69	62
								0000	000							220	195	155	130	112	97	87	77
									0000								220	195	164	140	123	109	98
Size of Wire B & S.				0000	000	00	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Safe Current, Amp.				220	190	165	140	120	102	87	73	62	54	47	40	34	28	25	21	17	14	11	8

FEET.

CURRENT IN AMPERES.

THE LEYDEN HANDY WIRING TABLE.

Or, suppose we wish to carry 60 amperes 100 feet at 220 volts and 2 per cent. loss. From "62" in the column for "100 feet" cross to the column headed "1.8 per cent." at "220 volts," and we have No. 5 B. & S.

For 500 volts the table does not indicate above 2 per cent. loss; but higher losses and greater distances can readily be estimated by rememberıng that the cross-section varies inversely with the loss, and directly with the distance. In taking the size of wire from the table, care should always be taken not to exceed the safe-carrying capacity of the conductor.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—XI.

BY

Chas. Steinmetz.

VIII. Constant-current Transformers.

In chapter VI. we have seen that a properly designed transformer, when fed by constant primary E. M. F. compounds, that is, gives very nearly constant secondary

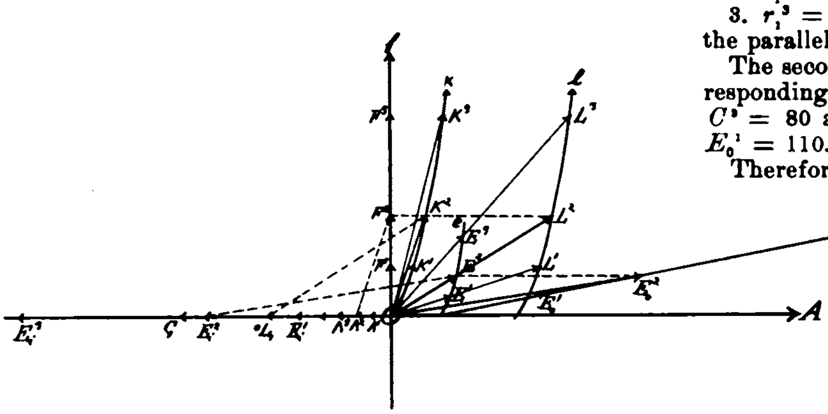


Fig. 23.

E. M. F., so that a slight regulation of the primary impressed E. M. F. would be sufficient to give absolutely constant potential at the secondary terminals; but that, even if it is not practicable to regulate the primary E. M. F. according to the load, the primary terminal pressure being kept constant by the dynamo-alternator, the secondary E. M. F. of a well-designed transformer will remain constant enough for all practical purposes. On the other hand, when fed by an alternate current of constant effective strength in the primary, the transformer gives about constant effective strength in the secondary circuit, within wide limits.

To consider this phenomenon, we first suppose, in the diagram, Fig. 23, that the *secondary current* is kept constant; $C_1 = \overline{\text{O C}_1}$. Then the *secondary* M. M. F., $L_1 = \overline{\text{O L}_1}$, is constant also. Therefore the *secondary* E. M. F. $E_1 = \overline{\text{O E}_1}$, must vary, from E_1^0, the value just sufficient to overcome the internal resistance, r_1^0 of the secondary coil at short-circuit, increasing proportionally to the increasing secondary resistance r_1. The *induced primary* E. M. F., E_1, also varies proportionally. Hence the *resulting* M. M. F., $F = \overline{\text{O F}}$, must vary from its minimum value, F^0 at short circuit, increasing proportionally to E_1, that is, E.

Thus the *impressed* M. M. F., K, travels on the curve of magnetic lag, the cubic parabola k, from K_0 at short-circuit, upwards.

The *primary* M. M. F., L moves along a parallel and congruent cubic parabola, l, which, because of the parallelogram of M. M. F.'s, O L_1 K L has the horizontal distance L_1 from the curve k. The *primary current*, C travels on a similar, or proportional, cubic parabola, and similarly the *primary resulting* or *heating* E. M. F., E, on the curve, e.

Because of the parallelogram of primary E. M. F.'s, O E, E E_0, the primary impressed E. M. F., E_0 travels along a curve, e_0, which intersects parabola e on line $\overline{\text{O A}}$, and is very nearly a straight line. Hence, for increasing secondary resistance, r_1, to keep the secondary current constant, the *primary current* $C = \overline{\text{O C}}$, and thus the *primary* M. M. F., $L = \overline{\text{O L}}$, have to increase, first very slowly, the slower, the smaller the coefficient of magnetic lag, γ, is; then faster, and at last, for high secondary resistance, almost proportionally to the secondary resistance.

The *impressed primary* E. M. F., $E_0 = \overline{\text{O E}_0}$ increases from a minimum value E_0^0 at short circuit, its increase being nearly proportional to the secondary resistance. The *difference of phase* between primary current and impressed E. M. F. increases with increasing secondary resistance.

In Fig. 23, the diagrams of the transformer are produced for the secondary resistances:

1. $r_1^1 = 1$ ohm.
2. $r_1^2 = 2$ ohms.
3. $r_1^3 = 3$ ohms.

the parallelograms being dotted in for $r_1^2 = 2$ ohms.

The secondary current being $C_1 = 50$ amperes, the corresponding primary currents are $C^1 = 45.8$. $C^2 = 56.6$. $C^3 = 80$ amperes, and the impressed primary E. M. F.'s, $E_0^1 = 110$. $E_0^2 = 183$. $E_0^3 = 323$ volts.

Therefore, below a certain critical value of secondary resistance, a transformer, when fed by constant primary current, will compound for constant secondary current beyond a certain value of secondary resistance; a transformer, fed by constant primary current, will compound for constant secondary E. M. F.

To consider this more particularly, produce, in Fig. 24, the diagram of a transformer, which is fed by *constant primary current.* But, to make the diagram simpler, we shall consider a constant current transformer, which has in its secondary coil the same number of turns as in the primary coil, $n_1 = n = 100$, so that the induced primary E. M. F. equals the secondary E. M. F., $E_1 = E_1$ and can be represented in the diagram by the same lines.

We need not remark, that this limitation is not essential, but that we can produce the diagram in the same manner for any other ratio of transformation. One ampere-turn being represented by .0003 inch, one ampere by .03 inch, in this diagram the curves of the current and of the M. M. F.

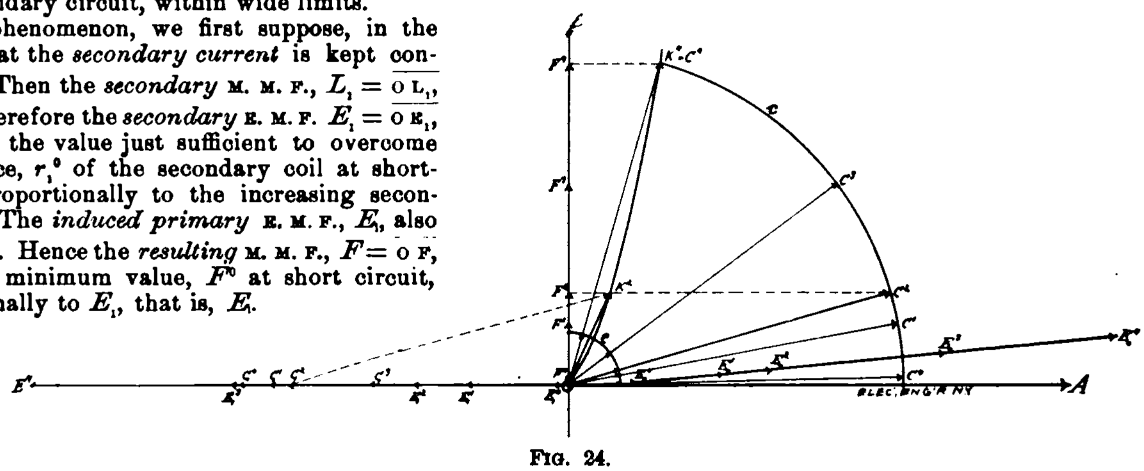


Fig. 24.

are the same, so that we only need to consider the curve of the current, and can apply the parallelogram of M. M. F.'s directly to the curves of the current.

The *magnetic resistance* of the transformer may be $P = .03$, hence the *resulting* M. M. F., F, will induce the E. M. F., $E_1 = \dfrac{2\,\pi\,N\,n\,F\,10^{-8}}{P} = .025\ F$ volts.

If now the *primary current* is kept constant, at 65 amperes, for instance, then the point C must lie upon a circle, or rather a quadrant, with $\overline{\text{O C}} = c = 65$ amperes as a radius, and O as centre.

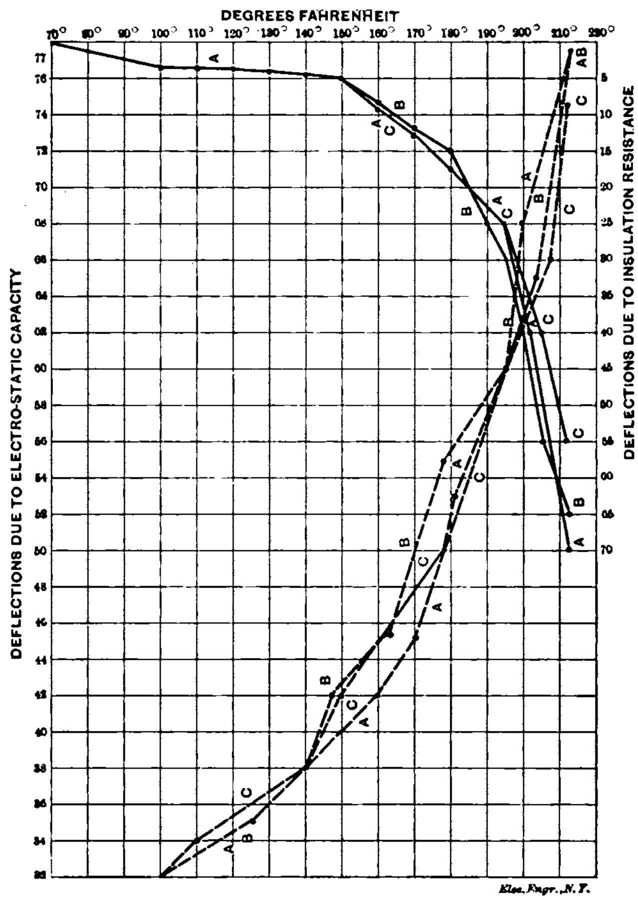
This quadrant is shown in Fig. 24 as c, and gives in this case also the curve of primary M. M. F., L.

EFFECTS OF HIGH TEMPERATURES UPON THE INSULATION RESISTANCE AND INDUCTIVE CAPACITY OF VULCANIZED INDIA-RUBBER.

BY

Wm. Maver, Jr.

In some of the streets of New York City an abnormally high temperature exists underground, caused by defective pipes of the New York Steam Company. In certain ducts and manholes of the electrical subways in the locality heated by the steam pipes, the temperature has been found to range at times from 110° F. to 200° F.



Effects of High Temperature on India-Rubber Cables.

It was early found in the case of certain forms of fibrous, lead-covered cables that the insulation resistance fell very rapidly above 125° or 150° F. It was already known that the low softening point of gutta-percha, 115° F., unfitted it for use in the presence of high temperatures. The hardening effect of prolonged heat upon vulcanized india-rubber was likewise known, so that no difficulty was anticipated from the softening, and consequent decentreing, of the conductors encased in that compound; but there was no ready data as to the effect of high temperatures upon the insulation resistance of india-rubber compounds, and it became, therefore, a matter of interest to ascertain the actual effect of such temperatures upon such compounds, a considerable amount of which was being used in the electric light service in various portions of the subways.

To ascertain this effect the writer undertook a series of tests, the results of which are shown in the accompanying diagram. Tests were also made at the same time to ascertain the effect of high temperatures upon the inductive capacity of vulcanized india-rubber, the results of which are also shown.

The cables tested were three in number, A, B, C, in the diagram, each 100 feet in length. The cables originally belonged to one piece. The conductor was .097 inch in diameter. The outside diameter of the insulating material was .350 inch, approximately $\frac{11}{32}$; hence the thickness of the insulating wall was .126 inch.

Cable A was unbraided and not lead covered.
Cable B was unbraided and lead covered.
Cable C was braided and lead covered.

This arrangement of the cables was chosen purposely to learn the effect, if any, of such coverings in diminishing the effects due to high temperatures.

A Thomson reflecting galvanometer was used, and for simplicity the results of the tests are plotted on the diagram from the deflections; the resistance and capacity being, as is well known, practically proportionate to the deflections. The readings for the capacity tests were, in each case, taken at "charge"; those for the insulation resistance after one minute's electrification, that is, one minute after the depression of the charging key. Preliminary tests of the cables had shown the insulation resistance to be 1,500 megohms per mile at 70° F.

In the diagram the insulation resistance readings are arranged to increase from top to bottom of the diagram, that the curve may properly indicate a fall in the resistance due to the increased degrees of temperature; while the capacity readings are arranged from bottom to top, so that the curve may graphically indicate the increased inductive capacity found to be due to increased temperatures. To further avoid confusion the capacity curves are shown dotted, the insulation curves, solid.

The working constant of the galvanometer at the time of tests was 35,000 megohms. Hence it will be seen, for example, that the total insulation resistance of cable A fell from 7,000 megohms at 150° F. to 500 megohms at 212° F.; that of cable B, from 7,000 megohms at 150° F. to 538 megohms at 212° F.; that of cable C, from 7,000 megohms at 150° F. to 636 megohms at 212° F.

Calculated per mile, the insulation resistance of A would be, at 150° F., 132.5 megohms; at 212° F., 9.5 megohms; that of B at 150° F., 132.5 megohms; at 212° F., 10.02 megohms; of that C at 150° F., 132.5 megohms; at 212° F., 12.4 megohms.

It is, however, unlikely that such high temperatures as these will ever be met with over a continuous extent of territory amounting to one mile. In practice such temperatures have not hitherto been found to extend continuously for more than 50 or 100 feet. Hence, assuming the normal insulation resistance of a cable practically similar to those tested to be as stated, 1,500 megohms per mile, it may be observed that even with a one hundred foot section of the cable exposed to a temperature of 212° F., the cable, as a whole, would show an insulation resistance of, approximately, 450 megohms per mile. From the results of the tests it may also be seen that any one foot of the cable would possess at 212° F. an insulation resistance of, approximately, 63,000 megohms, while any one inch of the same cable would possess an insulation resistance of 756,000 megohms at the same temperature.

Concerning the effect of ordinary changes of temperature on the electrostatic capacity of conductors, Kempe states: "The exact effect has not, it is believed, been yet determined or published." The capacity tests of the cables in question, as will be seen by reference to the "capacity" curve in the figure, indicate a marked increase in the inductive capacity of the insulating material between the temperatures of 100° F. and 212° F., namely, an increase of nearly 140 per cent.

The capacity of C at the boiling point was somewhat less than that of A and B; which result, it is assumed, indicates that the cotton braiding acted, measurably, as a non-conductor of heat. It may be noticed also that, in both the insulation and capacity tests, the curves for c indicate a more uniform effect due to the increasing temperature.

The foregoing tests, which extended over a period of six hours, were made while the cables were immersed in water in a vat. The temperature of the water was gradually raised to the boiling point. The final tests were made after the cables had been subjected to the boiling temperature for over one hour. Immediately after the final tests the temperature of the water was reduced to the normal, when it was found that the insulation resistance and capacity of the cables were again practically normal.

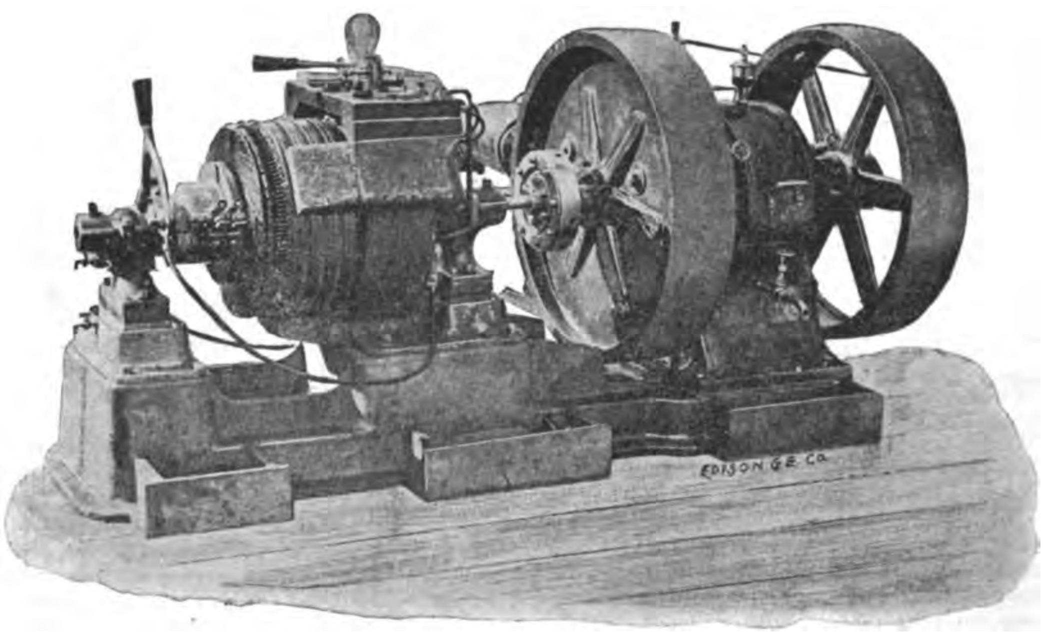
It may be of interest to note that for over one year "high" potential electric light circuits have been successfully operated through ducts in the "heated districts" of New York City, and without any perceptible deterioration in the insulation resistance of the cables.

EDISON COMBINED DYNAMO AND ENGINE FOR ISOLATED PLANTS.

The limited space usually available for installing electric light plants in buildings makes it desirable to combine the dynamo and engine on a single bed-plate, and recognizing this, the Edison General Electric Co., has recently brought out the combination shown in the accompanying engraving. This consists of an "Ideal" engine with a 6x6 inch cylinder, designed to work with a steam pressure of from 80 to 100 pounds. This engine is coupled directly to an Edison marine dynamo, wound for 65 volts and 50 amperes, running at 500 revolutions per minute.

The over-all dimensions are as follows: Height 30 inches, length 50 inches, width 81½ inches.

The dynamo has been so designed that it will give its rated output with an increase in temperature of only 20° Cent. after 4 hours' continuous run.



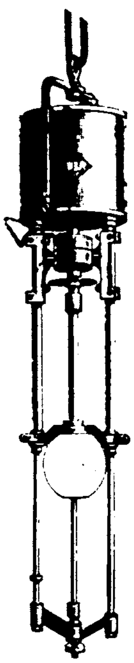
Edison Combined Dynamo and Engine for Isolated Plants.

Where, as stated above, space is confined and the temperature of the dynamo-room is high, as it usually is in buildings, such a combination plant ought to find many applications.

Mr. A. S. Temple, manager of the Salem, Mass., Electric Light Co., has resigned to accept the position of general manager for the U. S. of the Lamson store service system, with headquarters in Boston.

THE MIDGET ARC LAMP.

The great economy of arc, as compared with incandescent, lighting renders interesting any attempt to popularize the use of small arc lamps. For large shops or small lecture theatres something between the usual large arc and the ordinary incandescent lamp has long been wanted. It is absolutely necessary not only that these small lamps should possess perfect steadiness, but also that they should be so simple in construction that they may be relied on for keeping in working order without constant skilled attention.



"Midget" Arc Lamp.

A lamp fulfilling these conditions has just been brought out by Woodhouse & Rawson, United, Limited, of London. It is called the "Midget" from its small size, and is made to give 250 candle-power, using 5 amperes at an electromotive force of 45 volts, so that even with this small size of lamp one candle-power of light is obtained for the expenditure of every watt of electrical energy used. The illustration shows the general appearance of the lamp. The smallness of the globe prevents any depth of shadow, and minimizes any complaint which may be urged against the inequality of the distribution of the light. The principle upon which the lamp works is very simple. The upper part of the rods forming the frame of the lamp are hollow, and in these the lower portions slide quite easily. The bottom carbon is attached to the lower part of the frame, which is fastened to the upper portions of the lamp by a chain passing up the hollow pillar forming the upper portion of the lamp, round a pulley wheel, whose motion is controlled by clockwork, and then to the upper carbon holder, which acts as a counterpoise, and slides freely between the hollow pillars forming the frame of the lamp. The motion of the pulley is controlled by clockwork, which is started and stopped by a pivoted bar, on whose under surface a number of teeth are situated, which engage a pointer attached to the pendulum of the clock. This bar is pivoted in the centre and attached at each end to iron plungers, which move inside the cores of electromagnets actuated respectively by the main and shunt circuits.

When, owing to the distance between the carbon points, the resistance of the main circuit, and consequently the current through the shunt, increases, the plunger is drawn further into the core round which the shunt circuit passes and the pendulum is released, the clockwork moves the carbons nearer together until the main circuit increases so much as to draw the other plunger into the core round which it passes, and so overpowers the effect of the shunt circuit. The bar is drawn down, the teeth engage the pendulum of the clockwork, and the carbons are maintained apart until, owing to the burning away, the same action is repeated. This action is so delicate that no inconvenience at all is caused by the intermittent feed; indeed it is scarcely noticed. When the current is stopped the pendulum is released, owing to the action of a spring upon the bar, and the clockwork causes the carbons to come together.

In the small box over the upper carbon holder, the current, before passing to the carbon, magnetizes an iron core, and lifts the upper carbon a small distance above the lower one, thus forming the arc when the current is first put on the lamp. The carbon is held up in this manner all the time the current is passing through the lamp.

The lamp is wound in three different ways, one suitable for parallel working, one for series, and one for use with alternating currents.

THE WADDELL-ENTZ STORAGE CAR AT CHESTER, PA.

Our readers will remember the description[1] of the Waddell-Entz storage car "Direct," which was for some time in successful operation on the Lehigh Avenue Railway in Philadelphia. The heavy Sunday traffic on this road, however, necessitated the withdrawal of the car, which, on the invitation of the Union Passenger Railway Co., of Chester, Pa., was removed to that place and will soon be placed on the lines in regular service. Messrs. Wright & Starr, the agents for the Waddell-Entz system in that district, have already made a number of successful trial runs with the same equipment employed on the Lehigh Avenue Railroad.

The condition at Chester, are very different from those obtaining at Philadelphia, inasmuch that there are very few grades of over ½ to 1 per cent., with one exception, and this is a 7 per cent. grade. The severest grade on the Lehigh Avenue road was 5 per cent. and shorter than the Chester 7 per cent. grade.

The first three trips were made, not taking into consideration the number of people on the car, but merely to note the action of the car over the grades and the curves. On the subsequent trips from 50 to 65 passengers were carried. The president of the road, Col. Samuel A. Dyer, together with the superintendent, Mr. John Macfayden, expressed a strong desire to issue invitations to the Chester and South Chester councils, the directors of the road and the prominent citizens of Chester. Messrs. Wright & Starr agreed to have the car in readiness on the day which they had named, the 21st of July, on which day the invited guests were on hand at the car-stables to witness the method of loading the batteries. It was discovered about this time that the number of guests would be excessive for one car. They had anticipated this event and had prepared a drawbar four feet long to connect a summer car to be taken as a trailer on which the gentlemen who had been unable to get on the motor car "Direct" now took their seats in the open car. The total number of passengers was 66.

There is a considerable curve just outside the car-stables and they were a trifle anxious for the result, taking into consideration the fact of the trailer being coupled on; however, the signal for the start being given, Mr. Wright, who was operating the switch, threw the handle to the first position and quickly followed to the second. When the curve was reached all on board were gratified to find the cars go round with apparent ease.

The run was with one exception thoroughly successful, and this exception proved to be of use, inasmuch as it showed the remarkable working rate and strength of the Waddell-Entz battery. When the route was about one-half covered, and in ascending a 1½ per cent. grade, one of the terminals became unsoldered; this left only the first and second positions on the switch operative, which, however, were quite sufficient to bring the car home, though at a reduced speed. Upon reaching the station the unsoldered cell was cut out with a short piece of cable, the battery loaded on the car again, and with the president and superintendent of the road ran out again.

Subsequent to this two other runs were made for the purpose of getting an ampere current record. The first of these runs was with the whole equipment and with between 40 and 50 people on the car. The last run was made after having removed one of the motors and with 62 people on the car.

On one of the short curves of the road the car was stopped to ascertain the ability of the motor to start the car and carry it off. It was found that by first reversing and quickly throwing the handle around again the car moved off with considerable ease. The gentlemen interested feel that the experiments and tests have been severe and that the batteries and motors have shown themselves to be highly efficient.

Messrs. Wright & Starr, whose experience dates back to the beginning of the storage batteries, firmly believe that the Waddell-Entz battery exceeds in vital features anything which the lead storage battery can hope to do.

1. See The Electrical Engineer, May 13, 1891.

BALATA.

An exhaustive report on balata, or chicle gum, has recently been drawn up by Mr. G. S. Jenman, Government Botanist and Superintendent of the Botanic Gardens in British Guiana. The bullet-tree, from the bark of which balata is obtained, is a large forest tree ranging from Jamaica and Trinidad to Venezuela and Guiana. The tree grows to a height of 120 ft., and has a large, spreading head. The trunk is nearly cylindrical. The bark is about ½in. thick, with deep parallel fissures, an inch or so apart. The hard, reddish-colored wood is one of the densest in the colony, and is used for all sorts of purposes where great strength and durability are required. Dr. Hugo Müller, in a report on the substance, says: "It seems that balata is by no means neglected, and, in fact, it would find ready purchasers if more of it came to the market. It commands a higher price than gutta-percha. It is used in almost all cases in which gutta-percha is used, but, on account of its higher price, only for superior purposes. It seems that balata is treated by the manufacturers simply as a superior kind of gutta-percha, and therefore its name disappears when manufactured. Nevertheless, balata is distinctly different from gutta-percha, and this is especially manifested in some of its physical characteristics. For instance, it is somewhat softer at ordinary temperatures, and not so rigid in the cold. In one respect balata shows a very marked and important difference from gutta-percha, and that is its behavior under the influence of the atmosphere; while gutta-percha, when exposed to light and air, soon becomes altered on the surface, and changed into a brittle, resinous substance, into which the whole of the mass is gradually converted in the course of time, balata, on the other hand, is but slowly acted upon under these circumstances. The electrical insulating quality of balata is said to be quite equal to that of gutta-percha." The price for pure milk is 4s. per gallon, or occasionally a dollar, and for clean, well-dried balata, 1s. per pound. The yield of a tree varies according to circumstances. If favorable, a tree 15 in. to 20 in. in diameter, bled 8 ft. high, will yield three pints of milk.

"THE DUTY AND REWARD OF LOYALTY."

Mr. Allen R. Foote, himself an old Union soldier, and a badly wounded one at that, has issued a striking pamphlet entitled "The Duty and Reward of Loyalty." It is directed against the present pension system, and is written in a spirit of lofty and disinterested patriotism. It has received special notice and approval at the hands of the New York *Herald* and the New York *Evening Post*.

THE

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EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers*

VOL. XII. NEW YORK, AUGUST 12, 1891. No. 171.

A person is not entitled to a patent because he has invented a new word.—Judge Coxe.

THE EDISON CONVENTION.

IN view of the fact that the Association of Edison Illuminating Companies meets in this city during the current week, we have seized the opportunity for presenting, in the shape of a special Supplement, an illustrated survey of the Edison light and power industries as existing to-day and as compared with their humble beginnings of ten years ago. It is the first time, we believe, that such a sketch has been made of any of the great industries created by electricity and inventive genius in this country, and the reader will no doubt find in it many points of interest. Probably the fact it brings out more forcibly than any other is the rapidity with which electrical inventions have become part and parcel of modern civilization and comfort, and the varied manner in which these new developments affect every condition of social intercourse.

In fact, one of the most pertinent lessons to be drawn from our Supplement lies in its very emphasis upon this largeness and comprehensiveness of electricity as applied to light and power. There was a time, and not so long ago, when each of the local companies entering the field stood merely as the advocate or exploiter of one peculiar and particular method of furnishing electrical service. The process still continues. It had, and has still, many advantages, but it is a feudal method at best, and falls infinitely short of the favorable conditions and generous opportunities of the hour. It cannot make for the profit of a station, or for the welfare of the public, when a local company so restricts itself that it can do business in only one way. It surely cannot promote professional spirit for any one to be only known as an "Edison man," or a "Thomson-Houston man," or a "Brush man" rather than as an electrical engineer, pure and simple, aiming at the best that can be done. There has in a word been too much of the bitter partisanship of the schools of theology, and too general an acceptance of the erroneous belief that salvation, electrically considered, was to be found in only one doctrine. Out of this conflict and narrowness, and the denial of the truth that there is "good in all," have come many of the evils that all deplore in electrical work.

But the times change, and we expect that the Edison convention this week, equally with the National Electric Light Convention in Montreal a month hence, will broaden the lines of its discussion and work. It cannot be otherwise. A great many companies that bear the name of Edison and were established simply to supply the Edison incandescent light are to-day operating apparatus also for arc and alternating circuits and are generating current for electric roads. Some of them are indeed as much arc lighting or electric railway companies as they are anything else. On the other hand, not a few companies actively represented in the National Association run Edison plants of one kind or another, and the tendency is to increase the number. Now if these conventions are to be of any practical benefit they must handle the topics in which delegates are interested and have traveled hundreds of miles to talk about. It seems to us that more and more the conventions should consist of the men who are actually, as presidents, managers, and superintendents, operating these plants; and the way to reach that end is to deal exclusively with the questions that concern the efficiency and prosperity of central stations or large isolated plants. Other questions are not proper for the floor of a large convention, but belong to the class of matters that concern in their private offices the individual parties, as licensor and licensee, manufacturer and purchaser. An Association that spreads itself all over creation as did the National at Providence last February, will quickly go to pieces; an Association that narrows itself down to a handfull of ultra-jealous and suspicious licensees, as did the Telephone, soon peters out.

The view of the situation that we have been suggesting may be got from another standpoint, or may be briefly stated in the dictum that the successful station of the future will be a composite station. The stockholders and managers of such stations, of which the number is already far larger than is generally supposed to be the case, are in the field to render service in the most efficient and most profitable manner. If they want to reach a populous suburb, they will not be deterred from putting in an alternating machine because the bulk of their incandescent lighting is done on direct current. If they have the chance, they will not hesitate to load their direct incandescent circuits with arc lamps made for that purpose. If it will pay, they will run special day circuits for motors. If they started with an incandescent plant, they will be ready to do regular arc street lighting should occasion arise. If they find it worth while, they will absorb the local horse railway, make it electric, furnish the current, and then throw motors by day and arc lamps by night on the railway mains. When winter comes they will take off the fan motors and put on electric heaters. We say they "will" do it, but these things are actualities of the present, and the companies, large or small, that are thus shaping their policy know that their example is daily more and more imitated, with the result that the whole industry throughout the country, whether as to ownership or as to the make-up of the various plants, is undergoing a change that places it in the front rank of desirable and stable investments.

In view of what has been said above, the general accuracy of which no one, we believe, will question, it is certainly desirable that the Edison and National Associations should draw more closely together. More and more they are doing the same work, and the lines of distinction daily become less well defined. Sooner or later either of them may find itself superfluous, but before that happens they will, we trust, have become one. United they can do a great work, greater than either of them has been able to do singly, good and useful as that work has been.

THE LONDON ELECTRIC LIGHT STATIONS.

The recognition which was accorded to the merits of the electric light and its commercial development in America will always stand as a monument to American genius and enterprise. And it is safe to say that no art or industry of any time or character was ever so quickly and so thoroughly developed as that of electric lighting in America. In contrast to the rapidity of development here, the slow exploitation of the electric light in Europe for some time stood out in marked contrast. Conservative capitalists as well as conservative engineers long hesitated to give electric lighting the trial and opportunity which the results here might have warranted. But gradually European capitalists have awakened to the fact that the business of furnishing electric current for all purposes offers a most promising field for investment, and especially on English capitalists has this idea now been thoroughly impressed, and this is evidenced by the numerous and excellently equipped stations now in operation, or in course of construction, in London. Although the general arrangement of some of these stations has been the subject of criticism in some quarters, there is probably no question as to the fact that they are all equipped in the most substantial manner and provided with the most improved apparatus for the economical generation of the electric current. Our article this week on the Manchester Square alternating station in London will give a good idea of the methods adopted in this particular case. While the installing of such a large number of comparatively small power units may be criticised, the designers of this station have probably thoroughly weighed the question of the most economical arrangement of power units and adapted them to the existing conditions. It is also worthy of note that this station is at times completely shut down and its load taken by another station of the same company so that the highest economy in operation may be secured. We believe that this practice will shortly be followed in this country in stations belonging to the same company, and separated some distance, and now all operated during the light-load period with probably doubtful economy.

THE GREATHEAD ELECTRIC UNDERGROUND ROAD.

Some of the New York newspapers would have us believe that the underground electric road in London is not liked by the public and consequently languishes for want of traffic. There has, however, been a steady accumulation of evidence to the contrary, and now come various independent statistics, which go to show that the road is greatly preferred over the old methods of travel, even though they give "fresh air and bright sunlight." The New York *Times*, in its London dispatch of August 8, has the following: "Although it has been opened to the public for some eight months only, the little experiment of the underground railway, constructed on the Greathead tunneling system and operated by electricity from the city of London to Southwark, on the south side of the Thames, has already begun seriously to affect the short-traffic receipts of the other railway companies. At the half-yearly meeting of the London, Chatham and Dover Company, Mr. Forbes, the chairman, attributed the notable falling off of passengers on the short trips entirely to the competition of the City and South London Railway Company. He said his company had lost from this cause 38,482 first-class, 57,000 second-class, and 160,000 third-class passengers. These figures, unwillingly extorted from the chairman of the directorate of the company, speak well for the hold which the new system has already obtained over the public mind. It must be noted that the distance covered by the City and South London line is as yet only three and a half miles. With an extension of the system a much heavier blow to the existing companies must be expected."

These figures are more than ordinarily significant. It will be seen that the loss is not in any one class of travel, but is made up of all the three classes into which English passenger traffic still, as a general thing, divides itself. It also shows that Londoners have taken kindly to underground traction, the use of electric motors, and the charge of but one rate of fare. As to the stories of discomfort and inconvenience that have been circulated here, it can only be said that these figures do not reveal any hindrance to patronage on that account. Not long since, Mr. G. H. Guy had an admirable letter in the papers in which he cited the testimony and experience of Americans who had tried the road and were delighted with it.

There is a difference, however, between the conditions in London and New York—at least to this extent: there the roads are not overloaded with passengers as they are here. What is in London a preferable means of travel is here a vital and absolute necessity. There is no way out of the difficulties in New York but by going underground, and once underground, electric traction is essential. It is not necessary in support of this statement of the facts to prove that the innovation in London works perfectly or is free from every possible objection. It would be strange indeed if our American inventive geniuses did not hit upon a number of improvements, and already the system has attracted to its support and advocacy some of the men who have been foremost in introducing the electric street railway. The arguments against the system must be rare, indeed, when one of its newspaper opponents has to give editorial page prominence to the report of an accident to a hasty passenger in one of the elevators. Such reasoning, if it is good for anything. is not pertinent against underground electric traction, though it might be against the distinctive and pernicious American habit of using elevators rather than stairs.

ELECTRIC DISCHARGES IN VACUUM TUBES.

As was to be expected, the lecture delivered by Mr. Tesla in which he describes the illuminating effects observed in vacuum tubes, has called forth a number of communications from other experimenters who had, it appears, been working in the same direction. Mr. Tesla, it will be remembered, has succeeded in obtaining the effects observed by the employment of very high potential combined with a very high period of alternations, and ascribes the results as due almost, if not entirely, to electro-static action. Prof. J. J. Thomson, in his study of these phenomena, is led to the conclusion that luminosity in tubes without electrodes can be produced by electro-dynamic as well as by electro-static action. In proof of this he cites an experiment in which the electro-static action was ostensibly screened by covering the tube with wet blotting paper. It would seem doubtful, however, whether the precautions taken were sufficiently complete to avoid any electro-static action whatever, and for lack of further proof on this point final judgment may well be suspended. However, Prof. Thomson's experiments certainly show that the effects apparently produced by electro-dynamic action are greatly inferior to those due to electro-static action, and in this he bears out the point insisted upon by Mr. Tesla, that it is to the latter that we must look for the most efficient light production.

HIGH TEMPERATURES AND RUBBER INSULATION.

The placing of electrical conductors underground in New York City has labored under disadvantages probably not paralleled in any other city in the world. The innumerable pipes and conduits of all sorts already existing would in themselves have made the task one of no small magnitude, but the existence, also, of pipes carrying steam under high pressure, close to the electrical conduits, introduced a factor into the problem, the successful solution of which at one time indeed seemed problematic. But the attempt was made and we believe that the results accomplished will act as a stimulus for further work in this direction. The fears which had been entertained as to the destructive action of the heat on the cables appear not to have been altogether well founded and to still further investigate this subject, Mr. William Maver, Jr., the able electrical engineer for the underground construction company, made a series of tests, the results of which are detailed on another page. These experiments show that, as was to be expected, the insulation resistance fell with rise in temperature, while the electro-static capacity rose, but that even at the high temperature of 212° F. the rubber cable still possessed a good working insulation resistance, which would not unfit it for practical work. The result of actual experience with the cables in the conduits of the steam-heated districts of New York corroborates this result, it having been shown that a year's use with high-tension currents left the cables practically unchanged. It may be argued that it is still too early to form any definite conclusion as to the life of such cables, but sufficient time has, we think, elapsed to give at least some indication of the fact that the fears at one time expressed as to the absolute uselessness of the attempt to run cables in such heated places were groundless. As bearing on the question of the life of rubber at high temperatures while in contact with copper, some recent investigations of Sir William Thomson seem to show that metallic copper when heated to the temperature of boiling water in contact with rubber, exerts upon it a destructive effect, oxidizing it and thus rendering it brittle. These experiments also showed that platinum had only very slight effect under these conditions, while zinc and silver had no injurious influence whatever. As copper wires are as a rule tinned when covered with rubber insulation, the effect above noted would probably not take place, but it is to be regretted that the experiments above referred to did not include tin, so as to settle this point definitely.

Care of Electric Railway Apparatus.

One hears occasionally of queer things done with electrical apparatus, but the most extraordinary in the electric railway line is that reported from Lynn. There two of the electric cars met on a single track. Each conductor claimed the right of way and would not budge. The quarrel intensified and at last the motormen turned on full current and the cars were at once jammed together like angry bulls, each trying to push the other out of the way. The scene was a lively one for some time, and we need not wonder that the passengers became frightened while the cars butted. At last the superintendent appeared on the spot and suspended one of the motormen. It does seem that this treatment was altogether too mild. When men handle expensive machinery in this way and endanger passengers, leniency is a mistake. The fact that electrical apparatus is not built to be abused but to be taken care of like any other machinery is not yet as fully grasped as it can be. We know of instances where electric cars have been left outdoors for months, in all weathers, without attention after long daily runs, and then expected to be in first-class condition every morning. This is simply encouraging men to be criminally careless, whereas a little appeal to their personal pride will easily lead them to be as vigilant as the management in keeping apparatus in order.

A Handy Wiring Table.

The variety of wiring charts and tables now available would seem to make an additional one almost superfluous, but we believe that the table by Mr. H. R. Leyden, which we give in this issue, allows of a wider range of applicability and occupies a smaller compass than any table thus far seen. Its range includes all practical percentages of loss at the voltages most generally employed and its range of distances is also large. While a wiring diagram is an aid to many, there are not a few who are better able to work with a table such as the one we publish, which has been found to give good results in practice.

EXPERIMENTS ON THE ELECTRIC DISCHARGE IN VACUUM TUBES.

OUR readers will recall the communication of Mr. Nikola Tesla, in our issue of July 1, in regard to Prof. J. J. Thomson's experiments on the "Electric Discharge in Vacuum Tubes."[1] Mr. Tesla's communication, which was reproduced in the London *Electrician*, has elicited a reply from Prof. J. J. Thomson, published in that journal under the date of July 24, in which he says:

"Mr Tesla seems to ascribe the effects he observed to electrostatic action, and I have no doubt, from the description he gives of his method of conducting his experiments, that in them electrostatic action plays a very important part. He seems, however, to have misunderstood my position with respect to the cause of these discharges, which is not, as he implies, that luminosity in tubes without electrodes cannot be produced by electrostatic action, but that it can also be produced when this action is excluded. As a matter of fact, it is very much easier to get the luminosity when these electrostatic effects are operative than when they are not. As an illustration of this I may mention that the first experiment I tried with the discharge of a Leyden jar produced luminosity in the tube, but it was not until after six weeks' continuous experimenting that I was able to get a discharge in the exhausted tube which I was satisfied was due to what is ordinarily called electro-dynamic action. It is advisable to have a clear idea of what we mean by electrostatic action. If, previous to the discharge of the jar, the primary coil is raised to a high potential, it will induce over the glass of the tube a distribution of electricity. When the potential of the primary suddenly falls, this electrification will re-distribute itself, and may pass through the rarefied gas and produce luminosity in doing so. Whilst the discharge of the jar is going on it is difficult, and, from a theoretical point of view, undesirable, to separate the effect into parts, one of which is called electrostatic, the other electromagnetic; what we can prove is that in this case the discharge is not such as would be produced by electromotive forces derived from a potential function. In my experiments the primary coil was connected to earth, and, as a further precaution, the primary was separated from the discharge tube by a screen of blotting paper, moistened with dilute sulphuric acid, and connected to earth. Wet blotting paper is a sufficiently good conductor to screen off a stationary electrostatic effect, though it is not a good enough one to stop waves of alternating electromotive intensity. When showing the experiments to the Physical Society I could not, of course, keep the tubes covered up, but, unless my memory deceives me, I stated the precautions which had been taken against the electrostatic effect. To correct misapprehension I may say that I did not read a formal paper to the Society, my object being to exhibit a few of the most typical experiments. The account of the experiments in *The Electrician* was from a reporter's note, and was not written, or even read, by me. I have now almost finished writing out, and hope very shortly to publish, an account of these and a large number of allied experiments, including some analogous to those mentioned by Mr. Tesla on the effect of conductors placed near the discharge tube, which I find, in some cases, to produce a diminution, in others an increase, in the brightness of the discharge, as well as some on the effect of the presence of substances of large specific inductive capacity. These seem to me to admit of a satisfactory explanation, for which, however, I must refer to my paper."

MORDEY ALTERNATORS RUNNING IN PARALLEL.[2]

EXPERIMENTS were recently made at the engine works at Thames Ditton with two A. 9 Mordey alternators, each capable of an output of 50 h. p. at 666 revolutions per minute, the one being the machine commonly used for testing at the Lambeth Works; and the other a similar machine of an early pattern, used for occasional work. Two Willans engines, of their two-crank E size, were taken from stock, and were coupled direct to the dynamos. The governors were of the ordinary kind, simply taken from the stores, and used without any special adjustment. Neither the engines nor the dynamos were arranged specially for the work, nor were they suited for each other as regards output and speed. A pair of transformers were arranged in the usual way as a synchronizer, and a pair of lamps were placed in series with the secondary coils. The engines were started, and ran at about 472 revolutions per minute. Before attempting to switch them together, the great regularity of speed of the two engines, as shown by the synchronizing lamps, was very remarkable. The lamps glowed and faded at first rapidly, and as soon as both stop valves were opened, and the full speed attained, it was possible, by adjusting the governor of one to slow down the synchronisms to less than four a minute, and one long glow taken at random timed 28 seconds. It was very easy to select the best moment for switching on, and this being done both at light load, half, and full load, the fact was proved, which, though perhaps a foregone conclusion, had not actually been proved before, that a flexible driving, by belt or other elastic connection, is not only not necessary, but does not appear to offer any appreciable advantage, except in cases where the speed of the engine is very irregular during each revolution, owing to irregular turning moment. A load of about 36 kilowatts was put on, and the steam was shut off from one engine, leaving only about 5 lbs. to keep the connecting rod from lifting. The one machine took the load and drove the other as a motor, taking with it the engine, which requires about 25 lbs. of steam to move it. Some further experiments were carried out afterwards, to try the effect of a considerable resistance in the circuit connecting the two machines, and during these tests the switch was more than once intentionally pulled over a little before the moment when the lamps showed that the two machines were exactly in step, but the two armatures adjusted themselves instantly without any perceptible shock or noise.

These experiments remove one uncertainty in a most satisfactory and conclusive manner, and show that the difficulty is of a purely electrical nature, and depends probably on the presence of iron in the armature and the frequency of the alternations, because at high frequencies there is not time for the iron to respond to the pull.

1. See THE ELECTRICAL ENGINEER June 10, 1891.
2. London *Electrician*.

STATISTICS OF THE ASSOCIATED PRESS SYSTEM.[1]

BY W. H. SMITH.

THE records of the Western Union Telegraph Company may be consulted to show the extent of the expenditures by the individual newspapers and the Associated Press, for telegraphic tolls alone, on this largest telegraph system.

During the year ending June 30, 1890, the Western Union Telegraph Company delivered at all stations 322,088,438 words of "regular" or Associated Press report. This was delivered to an average of two newspapers in each place, at an average cost of 15 cents per 100 words for each place. This is rendered possible only by the great number of places served on a circuit—from 30 to 40 being supplied in some cases at the same time. During the same period the company handled 206,025,094 words of specials, at an average cost of 51 cents per 100 words.

These figures do not include reports transmitted by the Associated Press over its leased wires or special correspondence sent on individual newspapers' leased wires. Estimating these two classes and the reports of the outside press, there was delivered to the newspapers during that year an aggregate amount of 1,500,000,000 words of telegraph news. On the regular service a little more than 22 per cent. is handled by the telegraph company in the day-time, while on the special service only about five per cent. of the volume is handled in the day-time.

The day rate is twice the night rate. On the Associated Press leased wires the proportions are 34 per cent. of day report to 66 per cent. of night, and the difference in cost the same as by Western Union lines. The total press receipts by the telegraph company for the year ending June 30, 1890, including regular, special, and leased wires, were $1,848,247.23.

It should be borne in mind that these figures do not include tolls on other lines, or cable tolls, or the wages of correspondents and operators, or miscellaneous expenses, or the sums paid for news by both individual newspapers and the Associated Press, which would aggregate a very large sum.

One very interesting feature of the news service, of which the public has no knowledge, is telegraphing in cases of storms and interruptions. It is on such occasions that the utility of a vast system is made manifest. During the blizzard of March, 1888, for instance, the Washington report was sent to Philadelphia via New Orleans, Memphis, St. Louis, Chicago and Pittsburgh; while New York City received it from Albany, it having reached Albany via New Orleans, St. Louis, Chicago, Cleveland and Buffalo.

A more extraordinary case is that of Boston, which received a condensed report from New York via London, it being sent by one cable from New York to London, and thence back by another cable which lands in New Hampshire. Boston is frequently served with New York news via Montreal, and Albany via Pittsburgh and Buffalo, the route being via the Pennsylvania railroad to Pittsburgh, thence across via Cleveland to Buffalo, and thence down the New York Central to Albany.

"ITS LATEST PIECE OF ENTERPRISE."

THE following appreciative paragraph is from the *Boston Transcript* of July 25: "THE ELECTRICAL ENGINEER, of New York, is nominally a weekly magazine, but when anything of more than ordinary interest in the electrical world occurs, it does not hesitate to issue an extra edition in order that the public may get immediately reliable data on the subject. Its latest piece of enterprise was the publishing of an Extra giving the full opinion in the incandescent lamp suit."

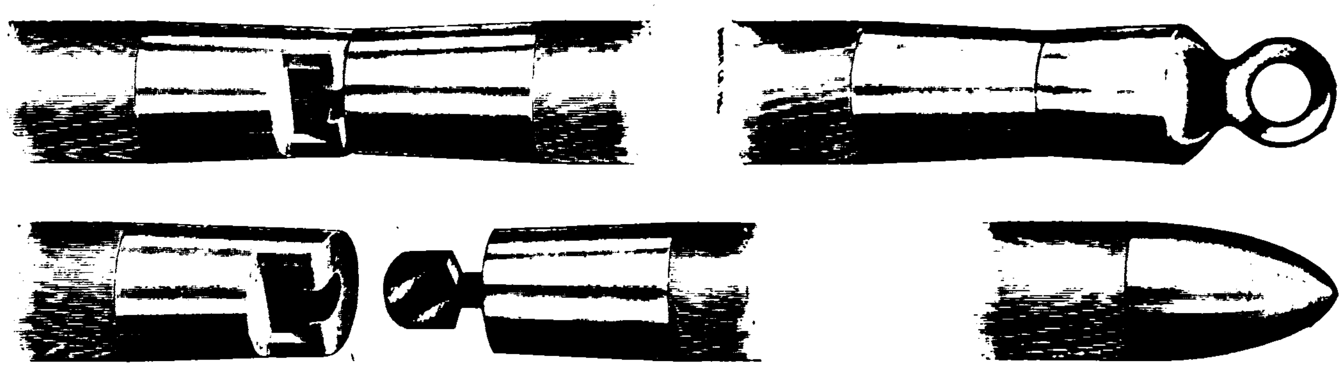
1. From article in August *Century*.

RAPID TRANSIT IN NEW YORK.

Some recent episodes in the movement to secure rapid transit for New York are of more than ordinary interest. The chairman of the Rapid Transit Commission, Mr. W. Steinway, was understood to declare himself as, after all, being in favor of getting very near the surface with an underground road, and as considering the Greathead system to be too expensive. Mr. F. J. Sprague, who has now allied himself with the Greathead interests in this country, took forcible and pithy exception to these views, as did some of the city papers. Mr. Steinway now comes forward to explain that he neither meant nor said anything of the kind; and thus everything gets back into the "as you were" attitude. But the episode has been of value in eliciting many expressions of opinion and not a few facts in favor of the underground electric methods of rapid transit. Certainly no one familiar with the state of the immediate sub-surface of Broadway and other main thoroughfares, believes that it is possible to have an underground road that does not dive down below all such obstructions and pierce its own way freely from one end of the city to the other. The motive power of such a road must of necessity be electricity, but the argument for electricity does not merely depend on the depth of the subway. The day has gone by when even in the shallowest sub-surface road anything else would be proposed.

ANDRAE'S CONDUIT WIRE DRAWER.

THE great difficulty experienced heretofore by electrical companies operating underground conduits has been in passing the first or dummy wire by which the cable itself is drawn in through the conduit. Gas-pipe rods with right and left hand threads have generally been used. These require two men in each manhole, one holding the coupling while the other man screwed on the second rod. This is a very long and expensive mode. With the new patent rods just brought out by Julius Andrae, of Milwaukee, Wis., one man can thread a section of 450 feet in about 15 minutes and this with the greatest ease. These rods are made of the best hickory in two-foot lengths, and the joints are made of the best malleable iron. They are durable, light and cheap, and will last a lifetime. The first rod inserted from the manhole into the conduit is bayonet-shaped to overcome any roughness which it might encounter in the conduit, while the last or end rod has a swivel connection which will move around no matter how irregular the drawing-in wire may be. The apparatus is so effective, and meets the difficulties of the work so admirably, that it seems destined to very general use in the large underground installations now being made. The details are shown in the accompanying illustrations.



ANDRAE'S CONDUIT WIRE DRAWER.

THE GOOLDEN-ATKINSON SEPARATOR.

AMONG the machines shown at the recent meeting of the Royal Agricultural Society, at Doncaster, was a magnetic separator, intended to remove bolts, nuts, nails, horseshoes, etc., from bones, oilcake, or minerals, before they are passed into disintegrating machines, by the use of a hollow truncated cone with 10 internal magnets of alternately opposite polarity. The cone revolves on outside runners, driven by friction only, which is found ample for the purpose. The bones are fed into the back end by a shoot, and, falling to the bottom, are rolled over and over again, so that, as they gradually travel forward—in about 10 or 15 complete revolutions—to the front, they pass 100 to 150 times over the magnets. In the upper part of the barrel is a fixed tray, into which the iron is carried and collected. Each magnet in turn, as it comes to the bottom, is magnetized, and remains so till it reaches the top, where it becomes demagnetized, and the iron is detached. This process is carried out by a commutating ring on the back of the machine, and the arrangement is such that each coil has one end permanently connected to one pole of the dynamo, and the other ends are in turn connected during one-half a revolution to the other pole. Thus the magnets receive current in parallel. The power required to excite the magnets is about 600 watts for the largest size, capable of dealing with four tons of bones per hour. The machine was exhibited by the Hardy Patent Pick Company, of Sheffield, and was manufactured by Messrs. W. T. Goolden & Co., under the joint patent of Messrs. L. and C. Atkinson and G. W. Elliott.

SOUNDINGS FOR THE PACIFIC CABLE.

REAR-ADMIRAL BELKNAP'S survey of parts of the Pacific, preparatory to the laying of the proposed trans-Pacific telegraph cable, indicates that extraordinary difficulties will be encountered. His soundings show the existence of a trough or basin of extraordinary depth and extent along the east coast of Japan and the Kurile Islands, and under the Kuro Siwo, or Japan or Black Stream. The basin exceeds any similar depression yet found in any other regions of the great oceans. In a run of 30 miles after leaving the coast of Japan the waters deepened more than 1,800 fathoms, and upon the next cast of the lead the wire broke after 4,643 fathoms had been run out, without bottom having been reached. Thermometers specially constructed for deep-sea sounding were wrecked by the unprecedented pressures. The depth of the deepest cast—five miles and a quarter, the deepest water yet found—is sufficient to hold two mountains as high as Japan's great Fusiyama, one on top of the other, and then the summit of the highest would be nearly two-thirds of a mile under water.

ELECTRICITY AS A FRIEND OF GAS.

THE president of one of the leading gas companies of New York stated at the last meeting of the company that no greater benefactor to the interests of gas companies had ever been known than the electric light. In stating that the gas output of New York was doubling itself now in a period of six and one-half years instead of ten years, as before, he gave it as his belief that this phenomenal increase was due to the fact that the electric light had educated the human eye to demand more light, and that people are not satisfied with the volume of light that formerly satisfied them.

APPRECIATIVE OF POLE LINES.

THE following from the Ogden, Utah, *Commercial* is so contrary to the usual run of remarks about pole lines, that we cannot refrain from quoting it: "The poles for the electric wires are all set from the river bridge north to Five Points, and a *beautiful appearance* is added to this part of the city through this grand enterprise."

OTTAWA, CAN., ELECTRIC RAILWAY.

Thanks to the energy of Ahern & Soper, the city of Ottawa has been given a first-class electric railway, the system adopted being the Westinghouse. The opening of the road was recently celebrated by a public luncheon at which a number of the most distinguished men in the Dominion were present. It is expected that the road will materially assist in the development of the quarter of the city through which it runs.

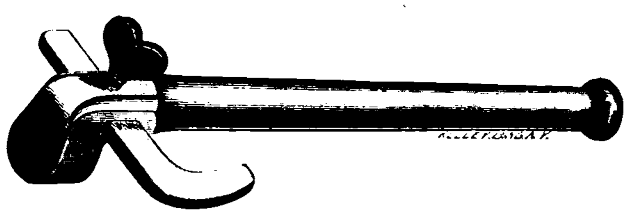
UNDERGROUND WORK IN WASHINGTON.

THE Electrical Board of the District of Columbia, Andrew Rosewater, C. E., chairman, have about concluded their labors, having made a very thorough and practical investigation of the whole subject. The report and estimates are now being prepared by Mr. Rosewater, at his Omaha office. They will be formally signed and presented by the members of the Board at their final meeting in Washington, in the early part of October.

THE VAN DYCKE WIRE SPLICER.

In putting up electric light, telegraph, and telephone wires, in the construction of wire fences, and, in short, wherever and for whatever purpose great lengths of wire are used, the splicing of the different pieces is a matter of inconvenience and difficulty. In order to facilitate this operation, Mr. J. D. Van Dycke, of Oneonta, N. Y., has devised the exceedingly simple and efficient tool shown in the accompanying illustration.

Its use will be readily understood. The wires to be spliced are held so that the ends lap over each other several inches. Midway between the ends the wires are held by a clamp, and each end is then bent out at a right angle to its original direction. One end is then passed through the hole in the end of the splicing tool until the hook engages the main portion of the wire, when, by rotating the free end of the tool about the main wire as a centre, the end is drawn around it helically to any desired extent. When the other end has been treated in the same manner the splice is complete. As may be imagined, the work is done quickly and with very little trouble.



Van Dycke Wire Splicer.

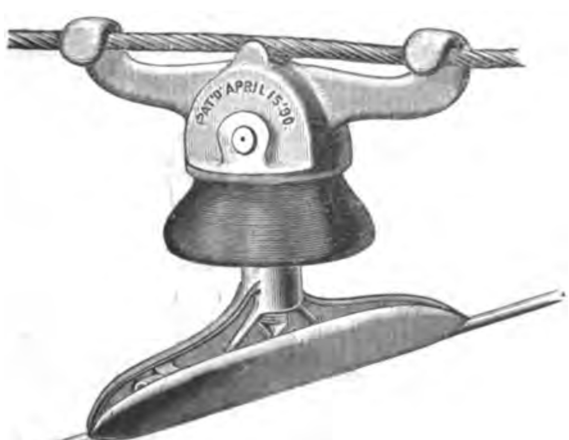
The hook is adjustable for the purpose of taking wires of any thickness.

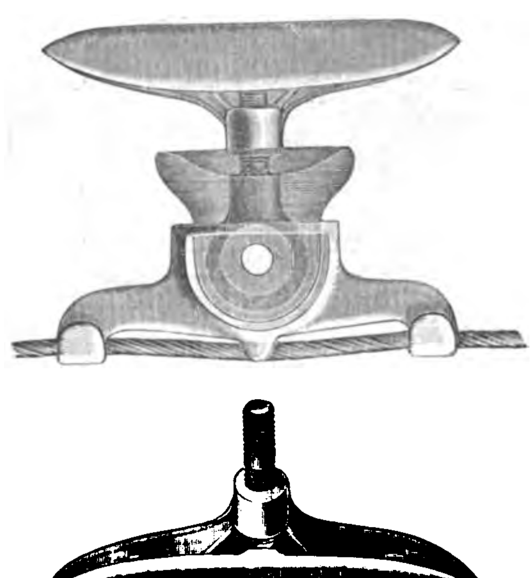
For the purpose of making spiral springs the wire is held in exactly the same way, and wound about a mandrel.

This instrument is made in three sizes, and is controlled by Messrs. Stevens & Hills, of 113 Main street, Oneonta, N. Y., who are now placing it on the market at a moderate price, and who have already found it to give great satisfaction wherever tried.

THE "UNIVERSAL" TROLLEY WIRE CLIP.

Among the electric railway specialties manufactured by the Lieb Machine Works, of this city, which have met with considerable favor, is the Universal trolley wire clip, illustrated in the accompanying engravings. It will be noted that the construction is such that the clip can take in any size of trolley wire and grips it firmly. In order to provide for expansion and contraction of the line, the clips are suspended by a link imbedded in a fireproof asbestos insulating material moulded around it. The construction is such that should the insulation break or be destroyed in any manner the line still remains suspended.





The "Universal" Trolley Wire Clip.

PLANT FOR THE MASONIC TEMPLE, CHICAGO.

The contract for the electric light plant for the Masonic Temple, in Chicago, which will be one of the largest isolated plants in the world, has been awarded to the Western isolated lighting department of the Thomson-Houston Electric Co. The generating plant will consist of six 80,000-watt generators and between 7,000 and 8,000 lights wired.

This plant rivals in capacity either of the plants installed by the Edison Co. in the Auditorium Building, at Chicago, although the two plants together possess a somewhat larger capacity.

Competition for this contract was unusually keen, nearly every company in the field having made proposals, and the isolated department of the Thomson-Houston Co. naturally felt elated at their success, particularly as, in addition to the generating plant and wiring, an order was secured for 3,750 Thomson-Houston incandescent lamps and the necessary sockets.

SPEED OF ELECTRIC SIGNALS THROUGH AN OCEAN CABLE.

Recent experiments at McGill College, Montreal, under the auspices of the British and Canadian governments, to ascertain the longitude of Montreal by direct observations from Greenwich, have led to the determination of the length of time it takes a telegraphic signal to cross the Atlantic. The land line was worked into the cable by a repeater, and a circuit was arranged so that the signal sent from Montreal would go over the land lines to Canso, N. S.; thence over the cable to Waterville, Ireland, and return to Montreal again. Attached to the sending and receiving apparatus was a chronograph, which measured the time. Out of 200 signals sent it was found that the average time taken to cross the Atlantic and back again—about 7,000 miles—was a trifle over one second.

H. WARD LEONARD & CO.

Under the above title there has just been formed a new corporation whose principal office will be in New York City, and whose business will be that of electrical engineering generally, and special attention will be devoted to electric motor appliances, the transmission of power, the installation of central station lighting and power plants, the concealed wiring of large office buildings, hotels, etc., and plants in which advantages can be obtained by a combination of apparatus of various companies, such as alternating current systems, storage batteries, arc lights, etc.

A feature of the business of this concern, which is entirely novel, will be the supplying of expert information regarding engineering matters, the operation of different plants and upon the best methods and system of accounts in connection with the operation of electrical plants. Such information will be supplied by correspondence at a very moderate charge per annum.

Mr. H. Ward Leonard, who has just resigned as manager of the Lighting and Power Department of the Edison General Electric Co., brings with him an experience second to that of no other electrical engineer in the country, and the many new ideas which he proposes to carry out will probably lead to a distinct and valuable departure in the application of electric power. He will be ably seconded by his former assistants in the Edison Co., Messrs. A. S. Vance and E. H. Harrison, and we have no doubt that their united efforts will result in a most successful and lucrative business.

The company will be actively in business before September 1st. Their offices will probably be in the Columbia Building, No. 29 Broadway, New York City.

NEW DEVICES OF THE INTERIOR CONDUIT AND INSULATION CO.

THE handsome new catalogue of the Interior Conduit and Insulation Co., of this city, besides containing excellent descrip-

FIG. 1.—CEILING PENDANT CUT-OUT FOR CONDUIT TUBES.

tions of the well-known products of this company, brings out also the latest devices made by them, and which deserve more than passing mention on account of their exceedingly practical character. Thus we note the ceiling pendant cut-out for conduit tubes, illustrated in Fig. 1, and designed especially where the tubes are run on the surfaces. It is made entirely of porcelain,

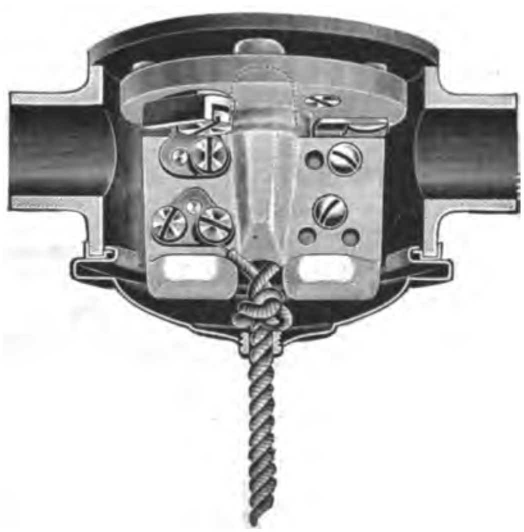


FIG. 2.—CEILING PENDANT BLOCKS FOR BRANCH CONDUIT BOXES.

the base portion being provided with side holes for receiving the tubes. These holes are curved so that the wires may be drawn in or out, and, therefore, the usual branch box is unnecessary. The terminals for connecting the wires are cast into the block itself, and, as will be seen from the illustration, the connection between the upper and lower pieces is made with a screw thread, so that no tools are needed to make the connection.

In Fig. 2 there is illustrated an improved form of porcelain ceiling pendant cut-out, designed with special reference to utilizing the space and protection afforded by the conduit branch boxes. By using this cut-out the necessity of making an outlet base at the branch boxes for the reception of the ordinary forms of cut-outs is done away with, and besides the advantage of having the cut-out concealed from view, it is at the same time well protected from any outside source of injury; and if the safety fuse is melted the fused metal is safely confined within the branch box. It can be easily applied, connected and readily handled.

Fig. 3 shows a pendant fixture made with conduit tube and suspended from the cover of the conduit branch box just described, making a flexible pendant, which is stronger and safer than ordinary flexible cord pendants.

The new spring snap-lever switches on slate bases, made by the company, are shown in Fig. 4, which illustrates the double-pole type. These switches are constructed on a novel principle, the merit of which will be at once recognized. The contact plates, which receive the bridges in the handle that close the circuit, are mounted on springs, which move with, and in the same direction as, the handle, and when sufficient power is stored up in the same break away instantaneously with a snap action. A simple screw adjustment provides for exact division of the small arc or spark. The contact plates are of the best phosphor bronze, and the action of the switch keeps the same always clean and bright, insuring the carrying capacity at all times. One important advantage possessed by the switch consists in the fact that the handle cannot fall on the contact plates and close the circuit

FIG. 3.—PENDANT FIXTURE SUSPENDED FROM CONDUIT BRANCH BOX.

imperfectly; and the design of the switch requires the exertion of force to close the circuit, and, therefore, insures its being done properly.

In addition to the apparatus described, we also note a variety of novel devices, among them an automatic switch operated at any distance by push buttons, and necessitating only a small wire between the switch and push button; various porcelain cut-outs designed for use in connection with the interior conduits, lever-switches, combined insulating joints, and cut-outs,

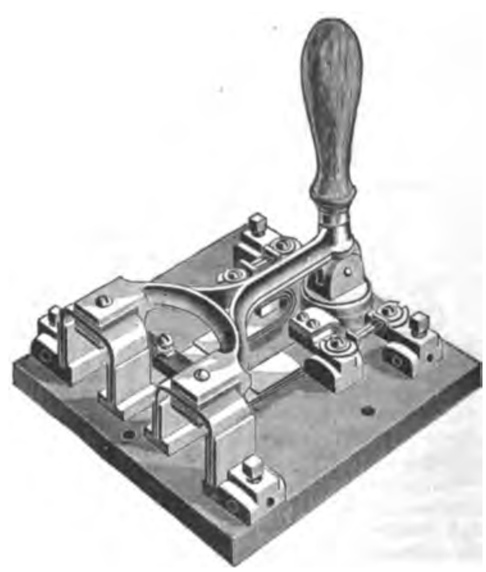


FIG. 4.—NEW SPRING SNAP LEVER DOUBLE-POLE SWITCH.

fixture cut-outs and safety catches, and a variety of fixtures for conduit branch boxes, etc. The catalogue, which is excellently illustrated, ought to be in the hands of every one interested in electric light installations.

Literature.

Telephones: Their Construction and Fitting. A practical treatise on the fitting up and maintenance of telephones and auxiliary apparatus. By F. C. Allsop. E. & F. N. Spon. London and New York, 1891. Price, $2.

WHILE many in this country are patiently awaiting the expiration of the patents which will throw open the telephone to free use, our English cousins are already on the threshold of this, in the opinion of many, glorious event. The Bell patent on the receiver did indeed expire in December of last year, in England, and before that time what was known as the "English Mechanic" receiver, with membrane diaphragm and electromagnets, was largely used by outsiders. On the 30th of July the Edison transmitter patent expired in England, throwing open to public use the battery transmitter, and it is interesting to know that on this patent, and not on that of the Blake transmitter, the United Telephone Company maintained their right to use a battery transmitter in England.

With this condition of affairs it is not strange that a volume describing in detail the construction of a variety of telephone apparatus should make its appearance. The author has, we think, succeeded admirably in the description of the various types of receivers and transmitters as well as the auxiliary apparatus necessary for the erection and maintenance of telephone lines, and we believe that any intelligent mechanic, or amateur, will be able to construct much of the apparatus described, owing to the clearness of the illustrations. For those who are clamoring for the most improved transmitters, such as those used on long-distance telephone lines in this country, it may be comforting to note that, although the National Telephone Company, of England, are the owners of the patent rights of most of the forms of microphones, including those of the Hunnings and Crossley type, they, nevertheless, adhere to the use of the Blake transmitter, and that, even, in the form illustrated in the original patent specification. The reason for this is evidently that the Blake transmitter is easy of regulation, and probably the best all-round instrument for holding up to its work.

Electric Transmission Handbook. By F. B. Badt. *Electrician Publishing Co.*, Chicago, Ill., 1891. 4 x 6 in., 97 pages. Price, $1.

ELECTRIC transmission of power has formed the subject of quite a number of valuable papers read before various scientific societies during the last few years, and much useful information has in this way unfortunately been scattered in various journals and transactions of such societies. The author has therefore done a good service in collecting the best of these papers and bringing them together in a form handy for reference. Thus the well-known papers on this subject by Kapp, Sprague, Mansfield, Spaulding, Leonard, and others have been brought together, and the tables and diagrams accompanying them will be found of use in the calculations involved in such work. It is to be regretted, however, that the author has not exercised greater care in coordinating the information contained in the material at hand, the work showing a lack in this direction. It is yet, we believe, too early to lay down comprehensive general laws for many cases involving transmission of power, and indeed it may appear later on that some of the laws at present enunciated and generally accepted may prove to have been based on false premises. Though not without considerable value, even at the present time, they may, however, in the future receive such modifications as practice and experience may dictate, so that a work of this kind must be used guardedly in order to avoid possible serious errors.

FOSTER'S "CENTRAL STATION MANAGEMENT AND FINANCE."

THE series of articles recently published in THE ELECTRICAL ENGINEER by Mr. H. A. Foster on "Central Station Management and Finance" have proved a great success. There has been a continuous demand for them, to meet which Mr. C. C. Shelley, Jr., of 10 and 12 College Place, N. Y., is now about to reprint them in book form. The book will be of handy size, and will contain not only the text, but all the forms, blanks, schedules, etc., employed by Mr. Foster as practical examples or to elucidate his suggestions. It would be difficult to find a more useful work for those engaged in central station work. The book will be ready in about a couple of weeks, and orders will now be received for it, either by THE ELECTRICAL ENGINEER or by Mr. Shelley. The price, in paper covers, is $1. Mr. Shelley has also made an exclusive arrangement with Mr. Foster to handle his copyrighted blanks, and will furnish samples and prices upon application.

College Notes.

ELECTRICAL COURSE AT TULANE UNIVERSITY, LA.

ANOTHER evidence of the advanced ideas of the New South seen in the fact that the Tulane University of Louisiana, of New Orleans, has a special course in electrical engineering. The University has a good faculty and is well equipped with apparatus The special course in practical electricity and related subjects is offered to such students as are unable to devote four years to the regular engineering course. This course extends over two years and includes instruction in mathematics, manual training, drawing, physics, chemistry, practical electricity, and French. On the successful completion of this course, a certificate will be awarded indicating the character and amount of the work done. Applicants must be not less than fifteen years of age and must be prepared to stand the regular entrance examination in mathematics, including arithmetic entire, algebra through quadratic equations, and six books of geometry. We should imagine that many students in the South desirous of following up electrical branches would be glad to avail themselves of this opportunity, especially as the fees are moderate. New Orleans is in many ways a central city and has a good many electrical establishments on a large scale as examples for study and test.

Society and Club Notes.

AMERICAN INSTITUTE EXPOSITION.

THE American Institute of New York City has issued announcements with regard to its sixtieth grand national industrial exposition, to begin September 30 and to close November 28. Applications for space, rules, information, etc., by intending exhibitors should be made at once to Mr. C. W. Hull, the general superintendent, at the offices, 113 West 38th street, this city.

Obituary.

WILLOUGHBY SMITH.

THE death of Mr. Willoughby Smith took place on Friday, July 17, at Eastbourne, England, where he had gone in the hope of gaining strength. He leaves six children, three sons and three daughters.

Mr. Smith was born in Yarmouth, Norfolk, on April 16th, 1828, where he remained until he took a position in the service of the Gutta-Percha Company, in 1848. His connection with submarine cables formed the theme of the two reviews on "The Rise and Extension of Submarine Telegraphy." This recent volume, which worthily closes the list of Mr. Smith's published works, really gives the history of the author's life-long labors until he retired, owing to failing health, from the Telegraph Construction and Maintenance Company in 1887.

In addition to his numerous papers presented to the Institution of Electrical Engineers, with which he was intimately connected from the beginning, he had also published lectures on "Induction," "Volta and Magneto-Electric Induction," "Induction and Conduction," and "Magnetism."

The death of Mr. Willoughby Smith snaps another of the few links in the chain which connects the men who in the old days were simply termed electricians, with the more modern electrical engineers, and only those who were associated with the early work of telegraphy can truly appreciate the great loss which the electrical world sustained by his death. At the funeral, which took place at Highgate Cemetery, the Institution of Electrical Engineers, of which the deceased was a Past-President, was represented by Profs. W. Crookes, F.R.S., President, G. Carey Foster, F.R.S,, Past-President, and the Secretary, Mr. F. H. Webb.

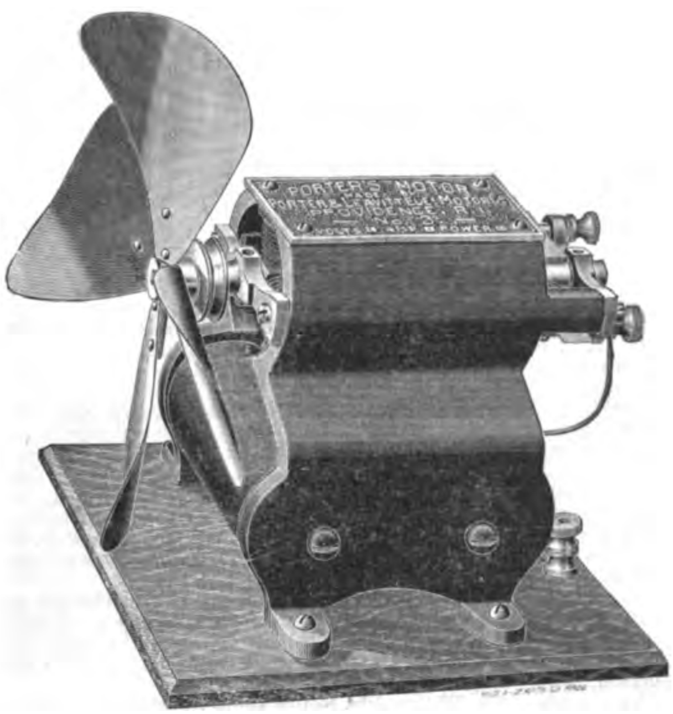
Appointments, Etc.

MR. F. SMITH, for ten years manager of the Salem, Mass., telephone exchange, has been elected manager of the Salem Electric Light Co., and will enter upon his new duties August 15.

MR. EDWARD R. GRIER and Mr. John J. Berger, formerly experts for the North American Construction Company, of Pittsburgh, Pa., are with the Thomson-Houston Co., at Lynn, Mass. Both these gentlemen have been prominently connected with the installation of the Westinghouse electric light plant in the Hoosac tunnel. Mr. Berger had charge of the rewiring of the tunnel during the past winter.

THE PORTER AND LEAVITT BATTERY MOTOR.

FOR some time back there has been an active demand for a good, reliable *small* motor, capable of being worked on a few cells of battery, and yet of such design that it would do good work and be at the same time cheap. There are a number of small motors on the market, but many of them, owing to their construction, are expensive, or have too much of the toy element. It is with pleasure, therefore, that we present to our readers the Porter & Leavitt motor, illustrated in the accompanying engraving, which seems to fill all demands, and which has met with remarkable success. These motors are patented, embodying many new principles, and are suitable for fan work or for driving small dental or jewelers' lathes, sewing machines, etc., etc. They are at present made in three sizes, No. 1, 2 and 3, but we will content ourselves with describing the No. 3, which is the largest, the most complete and the most efficient. The armature consists of two sections, on a single steel shaft. The sections are composed of three segments, each segment resembling a simple Siemens armature, made of cast iron and carefully annealed. There is no dead centre. They are insulated with varnish and paper and wound with No. 21, B & S covered wire. The commutator is made of a brass tube, mounted on a vulcanized fibre bushing, and is cut diagonally into three segments, which are fastened to the bushing by brass screws. The brushes are of solid, flat copper. The field magnets, of which there are two, lie horizontally at the bottom of the motor, and have vertical pole-pieces extending from them, curved at the upper end to fit the shape of the armature. Each field magnet is cast solid with one pole piece, and the two are then fastened together by screws entering the field magnets, one



THE PORTER AND LEAVITT BATTERY MOTOR.

at each side of the motor. The fields are wound with No. 14 B & S wire and are in series with each other, both giving the same polarity at the adjacent ends. The bearings are of brass, provided with a small oil recess. For fan purposes the No. 1 motor is fitted with a 5-inch fan, the No. 2 with a 6-inch fan and the No. 3 with a 7-inch fan, and they cost respectively $3, $5 and $7. The motors are thoroughly well made, and though small, have first-class workmanship, and everything is guaranteed by the manufacturers, who are at present also experimenting with motors to run on 110 volt circuits. They have been carefully tested by reliable electricians for their capacity, and the following data may be found interesting: The No. 1 weighs 1½ pounds, will run on one acid cell, taking 35 to 40 watts, and has a capacity of about $\frac{1}{25}$ h. p. The No. 2 weighs 3 pounds, takes from 60 to 120 watts, and has a capacity of about $\frac{1}{8}$ h. p. The No. 3 weighs six pounds, is 5½-inches long, 4¼ inches high and 4⅓ inches wide, and with 6 to 10 volts, and 20 amperes, has, while running at 2,205 revolutions per minute, a capacity of about $\frac{1}{5}$ h. p. The motors are manufactured by the Porter & Leavitt Electric Manufacturing Company, of Providence, R. I., and the Electric Gas Lighting Company, of Boston, are the exclusive agents for the New England States.

Reports of Companies.

ERIE TELEGRAPH AND TELEPHONE CO.

THE Erie Telegraph and Telephone directors met in New York, August 7, to declare the regular quarterly dividend of 1 per cent. as recommended by the executive committee. The dividend will be paid August 17 to stockholders of record August 8. The Erie's statement of operations for the first quarter of the fiscal year, ended June 30, makes the following comparison :

Quarter ended June 30—	1891	1890.	Increase.
Gross income	$208,782	$189,393	$19,389
Expenses and dividends	198,000	179,550	18,450
Surplus	$10,782	$9,843	$949
Proportion divs. rec'd by Erie Co	$52,287	$51,601	$686
Div. No. 31 (Aug., '91)	48,000	48,000	....
Surplus	$4,287	$3,601	$686

During the quarter 163 subscribers were added, making the total number connected July 1, 13,539, against 12,662 a year ago, and 11,564 July 1, 1889.

THOMSON EUROPEAN ELECTRIC WELDING CO.

THE Thomson European Electric Welding Company has granted the purchasers of the patents for Great Britain until Sept. 1 to pay the balance of £30,000 cash due upon the contract. The company has already received some $320,000. It has also extended the option of the German parties until Sept. 1. Trial machines have been sent to the South of Europe, on which a royalty is received, and there is a prospect of selling the rights for Italy, Spain and France. Beside this, the company has given a license for the use of the projectile patents all over Europe for a royalty on the welds made. It is thought by some that the projectile business will be the best of all the electric welding business in Europe.

THE APPLEGATE ELECTRICAL FLOOR MAT MANUFACTURING CO., of Camden, N. J., has been seized by the Sheriff on executions amounting to $2,000.

THE UNITED ELECTRIC SECURITIES COMPANY, of Boston, announces that it has bought for sinking fund under third call $50,000 of its first series collateral trust sinking fund 5 per cent. bonds.

THE DOMINION ELECTRIC MFG. CO., composed of Henry L. Shippey, John B. Wallace, C. E. Saunderson and Jas. Leggat, has been dissolved.

DIVIDENDS.

THE GREAT WESTERN ELECTRIC SUPPLY CO., at a meeting of its directors recently, declared a quarterly dividend of 2 per cent. on $350,000. of preferred stock. It is said they will soon pay 6 per cent. on the common.

HARTFORD, CONN.—The Hartford Electric Light Co. has declared the usual half-yearly dividend of 8 per cent., payable on demand.

A WESTINGHOUSE ROAD FOR WORCESTER, MASS.

MR. R. S. BROWN, representing the railway department of the Westinghouse Electric Mfg. Co., in New England, reports that the Consolidated Street Railway Co., of Worcester, Mass., is putting in an equipment of Westinghouse apparatus for its new line to Lake Quinsigamond. The single-reduction motor is to be used. Mr. Brown reports excellent prospects for New England business.

THE U. S. PATENT GUARANTY CO.

THE United States Patent Guaranty Company, of which ex-Senator John J. Ingalls is president, has been formed in Washington. It proposes to treat property in patents in much the way that the title-insurance companies treat property in real estate. Incidentally it will undertake the capitalization and exploitation of valuable patents, in regard to which it will occupy the relation of trustee. As a patent trustee, the Guaranty Company will be in a position to protect minority interests. Patentees with the certificate of the United States Patent Guaranty Company will more readily secure a hearing from capitalists, while inventors will find backing to protect them from the interests opposed to their possible competition. The names of several well-known capitalists and business men appear in the list of founders and directors.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED AUGUST 4, 1891.

Clocks:—

Clocks, W. K. Menns & W. J. Dudley, 457,090. Filed Mar. 8, 1890.
Relates to clocks in which the vibration of the pendulum controls the circuit of an electromagnet which actuates the impelling devices.

Dynamos and Motors:—

Armature for Dynamos or Motors and Method of Winding the Same, F. A. Wessel, 457,065. Filed Nov. 15, 1889.
Relates to drum armatures and is especially applicable to the winding of those of the Siemens type.

Brush Holder for Dynamo Electric Machines, Sidney H. Short, 457,226. Filed Dec. 18, 1889.
Relates to improvements in carbon brush holders for dynamos or motor.

Commutator or Contact Brush, L. Paget, 457,327. Filed Sept. 25, 1889.
Brush is composed of one or more layers of wire gauze cut bias.

Automatic Brush-Shifter for Dynamo-Electrical Machines, T. E. Adams, 457,330. Filed Sept. 16, 1887.

Galvanic and Thermo-Electric Batteries:—

Galvanic Battery, J. R. Hard, 457,116. Filed Feb. 6, 1891.
A closed cell has a gas outlet in its stopper and a self-closing valve opening outwardly.

Lamps and Appurtenances:—

Coupling for Electric-Light Shades, P. Levison, 456,997. Filed Mar. 23, 1891.

Incandescent-Lamp Socket, W. C. Bryant, 457,072. Filed Mar. 9, 1891.

Socket for Incandescent Electric Lamps, J. Criggal, 457,109. Filed Jan. 3, 1891.

Socket for Incandescent Electric Lamps, J. Criggal, 457,109. Filed Jan. 3, 1891.

Electric-Arc Lamp, X. Wertz, 457,141. Filed Dec. 5, 1889.
The carbons are enclosed in an exhausted glass globe; a layer of insulating material is interposed between the carbons.

Coupling for Electric Incandescent Lamps, I. J. Flagg, 457,151. Filed March 12, 1891.

Miscellaneous:—

Electro-Magnetic Cut-out, S. H. Cobb, 456,940. Filed Nov. 29, 1890.
A protective device.

Rheostat, J. A. Mosher, 457,090. Filed Nov. 5, 1890.

Mechanical Switch for Electric Systems, C. Dauffenbach, 457,110. Filed March 3, 1891.
A quick-acting switch.

Electric Hand-Fan, W. B. Luce, 457,127. Filed May 19, 1890.
A revolving fan and electric motor of small size with a handle and flexible conductors.

Electric Smoothing-Iron, W. Mitchell, 457,164. Filed Nov. 21, 1890.
Relates to tailor's irons and laundry irons heated by a removable coil.

Electric-Fence-Station Device, D. H. Wilson, 457,296 Filed Aug. 25, 1890.
Employs a battery and induction coils for the benefit or detriment of fleeing cattle.

Electric Switch, W. C. Bryant, 457,300. Filed April 8, 1891.

Electric Switch, L. D. Castor, 457,301. Filed May 20, 1891.

Electric Elevator, F. B. Perkins. Reissue 11,185. Filed June 24, 1891.
Original No. 439,180, Dated Oct. 28, 1890.
Relates especially to starting, stopping and braking devices.

Railways and Appliances:—

Car Propelled by Electricity, S. H. Short, 456,970. Filed Dec. 15, 1890.
Relates to a direct-acting system, the armature being axially placed with reference to the driving axle; the field magnets are mounted on side-bars connecting the pedestals and journal boxes of the car and are upheld by the journal boxes.

System for Conducting Electric Currents, E. Britt, 456,979. Filed Oct. 11, 1889.
Employs a series of distinct sectional conductors, which by means of pressure are brought into electrical connection with a continuous conductor.

Trolley for Electric Railways, S. H. Short, 457,015. Filed Mar. 29, 1890.
Employs a dash pot in connection with the trolley-arm for checking and limiting its upward movement when escaping from the trolley wire.

Electric Car-Brake, E. Verstraete, 457,016. Filed July 26, 1890.

Electric Motor for Street Cars, E. Thomson, 457,036. Filed Jan. 19, 1891.
Combines slow speed and maximum efficient torque, with compactness, in order to accommodate itself to the limited space beneath the body of a street car.

Electric Track-Signal, M. W. Parrish, 457,058. Filed Aug. 8, 1890.
Has for its object improvements in track signals, by means of which the incoming train gives an alarm while the outgoing train does not.

Electric Car-Brake, C. R. Arnold, 457,067. Filed Aug. 21, 1890.
An electromagnetic brake in which the circuit consists of two car wheels and the section of track between them.

Electric-Railway Motor, N. C. Bassett, 457,102. Filed Mar. 20, 1891.
Improvement consists of a water-tight case, and means for protecting the field-coil from injury.

Electric-Conductor Support, E. M. Boynton, 457,105 Filed Oct. 17, 1880.
Relates to an overhead conductor support and guide rail for the Boynton bicycle railway system.

Electric Conductor, E. M. Boynton, 457,106. Filed Dec. 15, 1890.
Similar in its object to No. 457,105.

Railway-Signal, W. C. Serrell, 457,135. Filed May 18, 1891.
An alarm to give warning of the too close proximity of two trains or locomotives.

Electric Railway, S. E. Wheatley & J. W. Schlosser. 457,240. Filed Apr. 2, 1891.
Provides for controlling the switch connecting the working conductor with the main line, by means of the main current and mechanical appliances on the car.

Telegraphs:—

Printing-Telegraph, H. Van Hoevenbergh, 457,239. Filed April 16, 1885.
Claim 1 follows:
In a printing telegraph, type wheel controlling device consisting of the combination of a scape wheel, an anchor applied thereto, an armature for controlling the movements of said anchor, a permanent magnet polarizing said armature, and two single coil electromagnets for controlling the movements of said armature.

ARC LAMPS ON RAILWAY CIRCUITS.

THE Universal Arc Lamp Co. have lately been introducing large number of their arc lamps on railway circuits with excellent results. Mr. L. S. Dumoulin, superintendent of the electrical department of the West End Street Railway Co., of Boston, in a recent letter to the company, says: "In reply to your inquiry respecting the arc lamps supplied by you, I am pleased to say that they are giving us good satisfaction every way. Our normal current is 500 volts, and we arrange the lamps in series of 10; and although subject to extensive variations of potential the light is both steady and constant. The twin carbons are a great success, and give 14 hours' light without causing any trouble." Similar results have been reached at Reading, Pa., and Amsterdam, N. Y.; and there is no question that this method of running arc lamps is destined to be very generally resorted to by street railway companies. Meanwhile the Universal Company is experiencing a large demand for lamps to go on regular incandescent circuits, where a great many are now in daily use.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE 1891 meeting of this Association will be held in Washington next week, from the 19th to the 25th. The headquarters will be at the Arlington, and reduced rates will also be obtainable at the Arno, Ebbitt, Randall and Fredonia. The meetings will be held at the Columbian University.

MR. F. ROBINSON, of Fair Haven, Vt., reports that there is a growing demand for slate for electrical purposes, with a decided appreciation of its many good qualities. The special sphere for slate is to be found in places liable to a burn-out, and hence it is particularly in demand for cut-outs, switchboards, etc. There is also a demand for new work in odd and original sizes and shapes. The chief drawback has been that much of the slate heretofore furnished has been poor in quality and of low-grade finish.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

The following are the last reported quotations up to August 8, 1891, from New York, Boston and Washington:

NEW YORK.

	BID.		BID.
W. U. Tel. Co.	78¼	Edison Gen. Elec. Co.	101
American Tele. & Cable	79	Edison Gen. Co. Def'd	....
Centl. & So. Amer	130	Consol'd Elec. Lt. Co.	...
Mexican	200	Edison Ilin'g Co. N. Y.	79
Com. Cable Co.	104¼	U. S. Elec. Lt. Co.	80
Postal Tel. Cable	25	North Am. Phonograph	..

BOSTON.

	BID.		BID.
Thomson-Houston	38	Ft. Wayne Co.	11¾
" Pref'd.	....	Am. Bell	176
" Series C.	....	Erie	48
" " D.	7	New England	50
" Int. Co.	....	Mexican	1.17½
Thomson Welding Co.	....	Trop. American	.80
Thomson Eu. Welding	....	Edison Phon'gph Doll	....

WASHINGTON.

	BID.		BID.
Penna. Telephone	24	U. S. Elec. Lt (Wash)	155
Ches. & Pot. Telephone	62	Eck.&Sold. Home Elec. Ry.	49½
Amer. Graphophone	5½	Ge'rget'wn & Tennallyt'wn	57

PITTSBURGH.

Westinghouse El. & Mfg. Co. ¾

THIRTEENTH ANNUAL CLAMBAKE OF THE AMERICAN ELECTRICAL WORKS.

A CLOUDLESS sky, warm, fair weather, a refreshing breeze, and about 210 guests, made the occasion of the thirteenth annual clambake at the Vue de l'Eau Club, Providence, on Saturday last, probably the most auspicious and enjoyable of any for a number of years. In past years these clambakes have always been held immediately after the electric light convention, and Mr. Phillips looks to the members attending the convention for a large number of his guests. This year, however, as the convention is somewhat later than usual in the season, the clambake had to depend altogether for its success upon its own attractions, and the result was most satisfactory and flattering to the American Electrical Works, as it was the most largely attended of any ever held. Everyone who could possibly attend was there, and Messrs. Philips' and Sawyer's hospitality was enjoyed to the full. Many anxious looks were pointed toward the weather quarter in the morning, as a violent thunder and rain storm had passed over sections of New England the preceding night, but in the morning all signs of rain had passed away and the event came off in as perfect weather as one could wish for. Guests came from all parts of the country and entered into the sports with that entire abandonment which characterizes the members of the electrical fraternity and which has made them known as "good fellows" all over the United States.

When your correspondent arrived on the scene a hotly-contested game of baseball was in full swing between the New York and Boston teams, resulting in a complete victory for Boston of 16 runs to 4, while New York claims to have completely demolished the Boston team by nine runs to nothing. Mr. W. A. Hathaway, of Providence, well known for his undoubted veracity, acted as captain for the New York team and efficiently steered them to success, while Mr. Charles B. Burleigh, one of Boston's brightest athletes, both in the field and in the arena of electricity, covered himself with glory as a batsman of renown. The actual result of the match probably will never be known to history, the proneness to ingenious prevarication of both captains on such occasion being beyond dispute. A *recherché* lunch was served to all the guests about noon, while a full and flowing bowl of punch of real Rhode Island merit served as a stimulus to drooping spirits, and got in some very subtle work. The usual photograph of the group arranged on the piazza of the club house was taken, after Mr. Day, of Providence, by sundry persuasions in the shape of brimming cups of punch, offered to the photographer, had prevailed upon Old Sol to kindly hide his shining face behind a convenient cloud. At three o'clock promptly dinner was served under a spreading awning and was enjoyed by all, especially the clams, which appeared to be as good as, if not better than, usual. After dinner, Mr. T. D. Lockwood made a very efficient croupier, and introduced the various speakers with a few bright and well-chosen remarks. The first toast in order was the American Electrical Works, which was very modestly responded to by Mr. Eugene Phillips, who simply took the opportunity of welcoming all his guests. The State of Rhode Island was then toasted and responded to by his Excellency the Governor, the Hon. H. W. Ladd. Mr. Lockwood then gave out the toast of the city of Providence, and Mayor Sidney Smith responded. Electricity, as represented by electric light and power, was duly responded to by Mr. A. J. De Camp, while Mr. G. M. Phelps, of THE ELECTRICAL ENGINEER, attended to that branch of electricity represented by the telegraph and telephone. Mr. Ralph W. Pope ably responded for the electrical press, and Mr. Martin Day, of Providence, kept the audience in a roar of laughter while apologizing for his existence as a member of the local daily press.

Most of the guests departed by the 5:45 boat for Providence, whence they separated for their various destinations, all agreeing that a most perfectly harmonious and pleasant day had been spent, and looking forward with pleasure to many more such outings, which undoubtedly go to produce good feeling and good fellowship.

Yes! Mr. Fred Gilbert's battered and time-stained hat still adorns the top of the telegraph pole, where it was carefully and laboriously placed some three years ago.

The names of those present are appended:

P. H. Alexander..........New York.
G. L. Austin..........Boston.
G. H. Almon.......... "
P. C. Ackerman..........New York.
J. E. Andrew..........Pawtucket, R. I.
G. W. Adams..........Boston.
D. A. Andrews.......... "
L. G. Banker.......... "
F. P. Baker..........Topeka, Kan.
A. D. Blodgett..........Boston.
W. H. Babcock..........Hartford.
C. E. Bibber..........Boston.
C. J. Birkenmayer..........Stamford, Conn.
W. I. Barker..........Boston.
F. H. Bibber.......... "
F. E. Bisbee..........Auburn, Me.
C. A. Baldwin..........Boston.
E. B. Baker..........New Haven.
M. W. Brown..........Boston.
Edward Byrnes..........Providence.
H. C. Bindford.......... "
R. S. Brown..........New York.
J. H. Bates.......... "
W. C. Bigelow..........New Britian, Conn.
Chas. Burgher..........Boston.
F. J. Boynton.......... "
C. B. Burleigh.......... "
J. K. Butler.......... "
F. S. Butwhistle..........Brookline, Mass.
M. P. Burbank..........Whitinsville, Mass.
I. F. Baker..........Lynn.
C. W. Baker..........Providence.
A. C. Barstow, Jr.......... "
R. C. Breck..........Bridgewater.
C. H. Barney..........New York.
D. J. Coburn..........Chelsea, Mass.
J. H. Clarke..........Boston.
Frank C. Chafee..........Providence.
A. P. Crowley.......... "
J. Carroll..........Montreal, Can.
W. H. Coughlin..........Worcester.
H. B. Cram..........Boston.
Edward Caldwell..........New York.
J. A. Coonly.......... "
J. F. Carney.......... "
S. L. Coles.......... "
M. E. Clemons..........Attleboro.
H. B. Cutter..........Philadelphia.
E. N. Clark..........New Haven.
Levi Cofren..........Boston.
F. X. Cicott..........Chicago.
E. M. Carhart..........Providence.
H. A. Cleverly..........Philadelphia.
I. H. Craig..........Boston.
F. W. Crocker.......... "
W. H. Clewley..........Riverpoint, R. I.
C. P. Chappell..........Providence.
Abner Coleman..........Taunton, Mass.
A. J. De Camp..........Philadelphia.
L. W. Dillon..........Attleboro, Mass.
J. O. Darling..........Providence.
Owen Durfee..........Fall River, Mass.
H. A. Day..........Boston.
N. B. Denison..........Pawtucket, R. I.
G. H. Darling..........Providence.
G. B. Davis..........Boston.
L. S. Dumoulin.......... "
M. C. Day..........Providence.
J. I. Drake.......... "
W. E. Decrow..........Boston.
W. W. Dempster..........Providence.
C. D. Dailey..........Windsor Locks, Conn.
H. B. Emery..........Boston.
Wm. Finkham..........Providence.
H. H. Fairbanks..........Worcester.
D. L. Fales..........Pawtucket.
J. P. Felton..........Boston.
E. D. Floyd.......... "
G. M. D. Fernald.......... "
G. W. Festes..........Andover, Mass.
E. W. Fyler..........Boston.
C. C. Fry..........Lynn, Mass.
W. C. Fish..........Boston.
C. A. Grant..........Lowell.
N. B. Griffin..........Stamford, Conn.
F. A. Gilbert..........Boston.
W. E. Geer.......... "
H. L. Greene..........Riverpoint, R. I.
J. J. Gates..........Hartford, Conn,
A. T. Gifford..........Hopedale, Mass.
F. M. Gilley..........Boston.
E. I. Garfield.......... "
D. A. Harrington.......... "
W. T. Hunt..........New York.
W. E. Holmes..........Newton.
C. H. Herrick..........Boston.
F. W. Harrington..........New York.
J. M. Hollywood..........Brockton, Mass.
E. C. Hughes..........Providence.
L. H. Hart..........New York.
F. H. Happer.......... "
G. H. Heathcote..........Providence.
L. C. Halst.......... "
J. F. Hedge, Jr.......... "
J. O. C. Hamill..........Bristol, R. I.
Otto Hoff..........Providence.

H. W. Hamblin	Portland, Ore.
W. A. Hathaway	Providence.
W. J. Johnston	New York.
J. C. Keefe	Syracuse, N. Y.
J. S. Keenan	Boston.
B. I. Keech	Providence.
W. S. Key	Boston.
F. M. Kimball	"
Henry F. Kellogg	Boston.
W. A. Leaman	Newton, Mass.
J. L. Lucas	Boston.
N. W. Lillie	"
L. H. Lang	"
S. W. Leedom	"
T. D. Lockwood	Boston.
H. C. Langstaff	Providence.
H. W. Ladd	"
W. B. Lewis	Lynn.
F. Luther	Boston.
C. E. Locks	Pawtucket.
F. H. Lord	New York.
E. D. Moore	"
W. N. Munro	Providence.
J. M. McLaren	Boston.
Will McGregor	Pawtucket, R. I.
Frank Murdoch	Newton.
H. M. Nicholls	Boston.
C. W. Price	New York.
G. F. Porter	Philadelphia.
G. M. Phelps	New York.
G. W. Phillips	Norwich, Conn.
N. H. Pearce	Harriswell.
R. W. Pope	New York.
H. L. Pierce	Leominster, Mass.
C. G. Perkins	Hartford, Conn.
E. F. Peck	Brooklyn, N. Y.
F. C. Pettingell	Boston.
C. G. A. Peterson	Providence.
H. J. Pettengell	Boston.
E. R. Phillips	Providence.
J. W. Poole	Boston.
T. R. Paysan	Providence.
E. C. Perkins	"
J. S. Reed	Providence.
A. S. Roger	Lynn, Mass.
Frank Ridlon	Boston.
C. R. Remington, Jr	Providence.
J. B. Straw	Boston.
S. S. Sherman	"
G. A. Steere	Providence.
Chas. Sydney Smith	"
E. A. Smith	"
A. C. Shaw	Boston.
G. R. Stetson	New Bedford, Mass.
S. S. Stiness	Pawtucket, R. I.
F. E. Smith	Somerville, Mass.
C. E. Stump	New York.
H. D. Sears	Lynn, Mass.
W. W. Stadler	New York.
Harry Stewart	Greenville, N. J.
George D. Stonestreet	New York.
H. H. Sherman	Auburn, R. I.
E. C. Stiness	Pawtucket, R. I.
A. P. Seymour	Syracuse, N. Y.
W. H. Sawyer	Providence.
A. O. Smith	"
A. D. Sayward	Providence.
H. P. Stanwood	Boston.
Jos. Taylor	"
E. R. Tilton	"
J. B. Tatens	Putnam, Conn.
V. A. Thomas	Providence.
R. S. Taber	New Bedford, Mass.
W. J. Thurston	Providence.
G. H. Thurston	Providence.
John Tregoning	Providence.
W. M. Turner	Boston.
C. A. Vialle	"
W. H. Vialle	Worcester.
E. M. Wilson	Pittsfield.
H. F. Woods	Boston.
C. N. Whiting	"
A. C. White	Providence.
C. H. Williams	"
R. H. Whittier	"
A. D. Wheeler	Boston.
George Wilmot	Uxbridge.
C. W. Whitney, Jr	Boston.
L. C. Whitney	New Britain, Conn.
Robt. Walker	New York.
G. H. Walbridge	New York.
H. G. Wright	Providence.
J. E. Whiting	Andover, Mass.
J. N. White	Providence.
Augustus Wright	"
E. E. Wood	New York.
W. K. Wagner	New Bedford, Mass.
W. F. Whittemore	Leicester.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

You put in the ad.; we do the rest.

THE MASON READING LAMP OUTFIT.

THE hot summer evenings make reading by gas or oil lamp intolerable and a small incandescent lamp fully meets all the demands of comfort and convenience. A neat electric lamp outfit has therefore been brought out by Mr. James H. Mason, 87 World Building, this city. It is illustrated in the accompanying engraving.

The zinc and carbon elements are attached to a board so that they can be lifted clear of the solution when the battery is not in use, and by opening out the hinged board in front, the cells can be easily got at. The box is made of solid walnut, beautifully polished, and is fitted with lock and key. A polished brass handle is screwed to the top lid so that the whole battery can be easily carried with one hand. The lamp-stand is attached to the two

THE MASON READING LAMP OUTFIT.

binding-posts on the side of the box, as shown, by means of 10 feet of silk-covered flexible incandescent lamp cord.

The lamp is of six candle power, but owing to concentration and the rays being thrown directly where desired, it said to be superior to many lamps claimed to be of sixteen candle power. The light supplied by the battery is a beautiful soft white, and comforting to the eyes, and can be turned on or off by means of the key over the shade.

One charge of solution, costing 10 cents, will run the lamp at a bright light for three consecutive hours, and the same can be used alternately for a long period of time

THE SUN ARC LAMP CO., 203 S. Canal St., Chicago, have a large demand for their Sun Arc lamps. This lamp is adapted to either arc or incandescent circuit. Several large Dry Goods houses with plants of their own are installing this lamp in place of the incandescent.

MR. J. W. MASON, the well-known dealer in electrical supplies, of Kansas City, was in Chicago last week.

THE "ISOLATINE" INSULATING AND PROTECTING PAINT.

OWING to the success "Isolatine" has met with in the market as insulation for wires, cables and underground work, as also to its well-known quality of not affecting, but permanently protecting, metals, wood, etc., the manufacturers have decided to put on the market a paint having all the qualities of Isolatine, and combining, it is claimed, as no other covering does, all that is necessary to lastingly protect and insulate, chiefly owing to the fact that it never either cracks or peels. For all parts subjected to vibration, jars, etc., it is specially recommended, and since "all the world is continually a-jarring," it follows that it should be in use for every conceivable purpose.

"Isolatine Paint" is very cheap, and only asks for a thorough trial to prove its superiority. The manufacturers, the Roessler & Hasslacher Chemical Co., No. 73 Pine street, N. Y., will be glad to answer all inquiries.

R. D. NUTTALL CO.

THE above-named concern, of Allegheny, Pa., has taken steps to increase its capital stock to $500,000, for the purpose of enlarging its plant and extending its business. It succeeds to the business of R. D. Nuttall & Co. and of the Electric Railway Specialty Co. Mr. J. F. Porter, the manager of the Specialty Co., will remove to Allegheny, where his time will be spent in looking after the affairs of the company. The Eastern office, at 29 Broadway, will be under the immediate supervision of Mr. J. G. White, electrical engineer. Messrs. Carey and Mayer will travel for the company.

BABCOCK & WILCOX BOILERS.

MR. L. M. MOYES, formerly agent of the Babcock & Wilcox Company, at No. 32 North Fifth street, Philadelphia, has surrendered the charge of the office and business at that point to their new agents, Messrs. W. C. Temple and Henry F. DePuy. Any business transacted with the Philadelphia office should be done through either of these gentlemen, who will always be ready to attend to it at that place.

PRATT'S PORTABLE REGISTER.

As another evidence of the enterprise shown by the Electric Merchandise Co., of Chicago, it may be mentioned that they have lately secured the sole agency for Pratt's portable register for street car use. They claim that this device has advantages of a special nature, and as a consequence they have been flooded with inquiries and orders during the last few weeks.

A NEW DEPARTURE.

MR. W. S. CHESLEY, of the Electrical Exchange Building, No. 136 Liberty street, this city, has established a purchasing agency for new apparatus and supplies, and proposes to give customers the benefit of low prices. He also makes a specialty of apparatus that is thrown on the market, and job lots of supplies that must be disposed of quickly.

JOHN P. CUSHING & COMPANY, of Boston, have just completed a very handsome stage switchboard for the new Empire Theatre, now in course of construction in Philadelphia, which is well worth examining, as being a perfect piece of work in all its details. The board is made of quartered oak 6 feet 6 inches high by 8 feet 3 inches wide, and sits on a cabinet 17 inches high by 8 feet 6 inches wide, containing the cut outs and bus bars. The whole board is protected by a roll top cover. Moulded mica, manufactured by the Gould & Watson Company of Boston, is used for mounting the heads, of which there are eight, which are connected to eight circuits furnished with resistance boxes for raising and lowering the lights. By means of a special shunt switch one of the heads can be used for three different circuits of red, white and blue lights. The board comprises 200 lights for the four borders, 120 footlights, 480 bunch lights, and 1,578 lights for the auditorium, which is controlled by fourteen different circuits. Ten circuits are on gang snap switches, which can be worked one at a time or altogether by means of a lever. The whole is controlled by one main breakdown, reciprocal-acting switch. The board was built under the supervision of Dr. W. A. Drysdale, consulting electrical engineer, of Philadelphia. Messrs. Cushing & Co. are building a switchboard for the new Columbia Theatre and for the remodelled Park Theatre, of Boston, and have already attained quite a reputation for this class of work.

MR. GEO. F. CARD, of the Fort Wayne Electric Co., was a welcome visitor to Chicago last week. He is investigating various matters electrical here.

TAYLOR & WALSH.

The above firm have started in business at 100 South Fifth avenue, New York City, for the manufacture of the Fibrous Battery in its dry and liquid forms, and of Leclanche fibrous cups. The firm comprises C. G. Taylor and Louis Walsh, with J. Hart Robertson as electrician. Mr. Walsh is well known through his active connection with the battery business, and his associates have also been identified with the industry. They bid fair to enjoy a large share of the trade in their line of specialties.

THE STRATTON SEPARATOR AT PURDUE UNIVERSITY.

MANUFACTURERS and steam users generally will be interested in the following communication:

"PURDUE UNIVERSITY,
La Fayette, Ind.

THE STRATTON SEPARATOR CO.,
32 Cortlandt street, New York.

GENTLEMEN: We have been using for about a year one of your 4-inch separators in connection with the compound engine in our engineering laboratory.

Steam for this engine is supplied by boilers located 580 feet away, and notwithstanding the long length of pipe through which it is thus required to pass, it was never found, by repeated calorimeter tests, to contain as much as 3 per cent. of moisture when it passes out of the separator, regardless of the amount of water previously held by the steam.

Very truly yours,
WM. F. M. GOSS,
Professor Experimental Engineering.

UNDERWOOD COTTON-LEATHER BELTING.

THE attention of readers is called to the illustration in our advertising pages of the four large Underwood Cotton Leather Belts. An agreement entered into last month by the Engineering Equipment Company, 143 Liberty street, New York, and the Underwood Manufacturing Co., of Tolland, Conn., constitutes the former company the sole Eastern selling agent for the Underwood Co. By this new move the Engineering Equipment Company assumes charge of the offices and salesrooms of the Underwood Manufacturing Co., at 126 Pearl street, Boston, in addition to the similar agency acquired at New York last February. Mr. W. D. Warner had been previously retired from the management of the Boston office, and the sale of Underwood Cotton-Leather Belting, Dodge Pulleys, and Rope Transmission is now in control of the Equipment Company, with Mr. F. A. Magee as their manager at the Boston offices.

"KIND WORDS."

UNDER the above title, Mr. W. J. Morrison, general agent of the Fort Wayne Electric Co. for New York State and Canada, has just published a most interesting pamphlet that contains a number of testimonials to the value and merits of the company's system of Wood arc lighting. What adds very greatly to the importance of the collection is that it was not made by the company itself. The letters, all of which are given in fac-simile, were received by the Board of Public Works of Jamestown, N. Y., whose secretary wrote inquiring as to the results that had been obtained with the Wood system, and as to experience with any other system. Hence they are characterized by a fullness and frankness that contributes very much to their weight, and Mr. Morrison is to be congratulated on his shrewdness in making the collection public.

THE AMERICAN LIGHTNING PROTECTOR CO.

Articles of incorporation of the American Lightning Protector Company have been filed at Sioux City, Ia. The company will have $100,000 capital. The incorporators are: Geo. W. Felt, Thomas F. Byron, A. H. Ward, H. R. Hopkins, W. F. Weyburn, H. S. Hubbard and L. S. Pearson. The provincial board of directors includes N. D. C. Hodges, the inventor of the device which the company will handle; W. H. Beck, Geo. W. Felt, A. H. Ward, Thomas F. Byron, Jennie E. Rogers, W. F. Weyburn, F. M. Ferris and H. S. Hubbard. The Hodges "dissipating conductor" has already been very fully described and discussed in our columns.

PUTTING TELEPHONE WIRES UNDERGROUND.

The telephone line from the summit of Pike's Peak to Manitou has just been completed and put in operation. It is said to be the highest telephone line in the world.

THE THOMSON WELDING PLANT AT JOHNSTOWN, PA.

The Thomson Welding Co., of Boston, are putting in a very fine welding plant for the Johnson Co. at Johnstown, Pa. A large brick building has been erected, 101x52 feet. There are five alternating current machines of the following capacity: Four of 80 kilowatts, and one of 40 kilowatts. These machines are run direct from the engines, Schieren belting being used. The engines are two 275 h. p., from W. A Greene, of Altoona; one 90 h. p. Ball engine; three 150 h. p. Ball engines and one 300 h. p. cross-compound Ball. This plant runs a Thomson metallic tie welder, a Thomson rail welder and two chair welders. Clark wire is used throughout the installation. The work, though the plant is not yet in full running order, is giving entire satisfaction.

THE OLD TIMERS' MEETING IN WASHINGTON.

The eleventh reunion of the Society of the U. S. Military Telegraph Corps and the Old Timers' Association will be held at the Ebbitt House, Washington, D. C., on August 19th and 20th. Mr. M. Marean is the secretary of the local committee on arrangements, with Mr. G. C. Maynard as his right hand man. The attendance promises to be very large, as Washington is a place of peculiar interest to those who were early associated with telegraphic work or were engaged in it actively as military telegraphers. Particulars can be had of Mr. W. J. Dealy, at "195." It is proposed to have a loan exhibit of relics, and to visit various places of interest.

INFECTIOUS TELEPHONES.

SOME officials at Danzig, Germany, are reported to have discovered that bacillary infection can be communicated by the membranes of telephones.

MR. FREDERICK DUGGAN, formerly general manager of the electrical department of the Trenton China Co., has purchased from them their entire plant for the manufacture of porcelain for electrical purposes, and has established himself as the Imperial China Works, at Trenton, N. J.

GEORGE CUTTER has just been granted another patent on his lamp-supporting pulleys, against which the rope-cutting demons are said to have a strong grudge, and perhaps the marking of the new date on the next batch of pulleys will give the little imps some satisfaction.

NEW YORK NOTES.

THE ONGLEY ELECTRIC COMPANY'S SYSTEM is meeting with success; the public have recognized the value of their reliable Watchman's Register, which faithfully records the movements of a night or day watchman, and its many adjuncts, viz., engine-stopping device, fire-alarm signals, automatic sprinkler protector, etc. Among the latest establishments which have been equipped with this system we may mention the Pennsylvania Railroad yards both at Jersey City and Hoboken; Eble & Herter's Brewery, Philadelphia, Penn., and the Appleton Manufacturing Company, of Brooklyn; and we learn that many other large and important concerns have just closed contracts with the Ongley Electric Company. The system is pronounced by all most reliable and thorough in all its workings. Particulars or any information may be had by applying to the company's office, at No. 1 Broadway, New York City.

MESSRS. MILLIKEN BROS., New York and Chicago, have lately gone to a great deal of expense and trouble to get complete tests made at Cornell University of their patent poles, showing ultimate strength, elastic limit and corresponding deflection in connection with standard pipe and wooden poles. This firm has shown great enterprise in trying to give to the public an improved and trustworthy pole. A complete report of the tests is promised.

THE MANITOU BEACH ROAD.—The new electric road to Manitou Beach, connecting at the lake with the Rochester and Ontario Beach line, is making a great success and will undoubtedly return good dividends.

MR. T. J. MURPHY, slate dealer, has removed from 96 Columbus avenue to the Electrical Exchange Building, 136 Liberty street. This is rendered necessary not only because of his increase in business, but also for the reason that he is making a specialty of slate for electrical purposes. Mr. Murphy furnishes a material entirely free from any conducting substance, and it can be had either plain, in black or marbleized. We can testify to the beauty of the latter style from a specimen which has reached this office in the shape of a checker-board. Small samples of the above may be had on application.

ROCHESTER, N. Y. NOTES.

TWO NEW THEATRES, with full equipment of electric lighting apparatus, will be opened in September. The Lyceum is making extensive changes and will have a good part of its large auditorium rewired.

THE WHITCOMB HOUSE.—The new six-story fireproof addition to the Whitcomb House is being wired in interior conduit for electric lighting by Putnam, Gay & Co.

PUTNAM, GAY & CO. are wiring the Rochester Free Academy building for electric lights in the insulating tubes of the Interior Conduit Co. for about 100 lights.

THE AMERICAN BREWING CO. are installing a 200-light plant in their six-story fireproof building. Contract taken by the Western Electric Co.

THE UNITED STATES COMPANY is adding a new alternator to its plant here.

THE STATE INDUSTRIAL SCHOOL.—The proposed plant fails to materialize. Bids were advertised for to be in by June 24th, but on that date it was decided to throw out all proposals and have specifications drawn up showing precisely what contractors would be expected to furnish. The first plan required contractors to furnish their own specifications, and it is supposed that the wide variations between bids caused the managers' course. It is unlikely that any decisive action will be taken in time to secure the plant this season.

NEW ENGLAND TRADE NOTES.

J. E. WILSON AND COMPANY, with headquarters at No. 8 Oliver street, Boston, are becoming quite well and favorably known as agents for the Rollins Engine Company, of Nashua, N. H., and of the Lawrence Machine Company, of Lawrence, Mass. The two engines do not compete with each other at all, the Rollins engine being made in sizes from 50 to 600 h. p., and the Lawrence engine from 4 to 30 h. p. Mr. Wilson, of the above firm, recently closed a contract with the Boston *Journal* to furnish them with a Rollins engine of 100 h. p. The *Journal* is increasing in size from its present form to a 16-page paper, and the order was secured in the face of severe competition, fully sustaining Mr. Wilson's reputation as a "hustler." The Rollins engine is of the automatic cut-off type, and has a Corliss exhaust valve and slide valve for the admission. At present there are two 250 h. p. Rollins in the Nashua Electric Light Station, one 250 h. p. engine in the station of the Concord Street Railway Company, two 100 h. p. engines in Newburyport Electric Light Station, and one 100 and one 125 h. p. engine in the station of the Amesbury Electric Light Company, at Amesbury, Mass.

THE WAINWRIGHT MANUFACTURING COMPANY, OF MASSACHUSETTS, have just furnished a 300 h. p. heater to the Reading and South Western Railway Company, of Reading, Pa., and two 600 h. p. compound engine heaters to the East River Electric Light Company, of New York. They have also furnished two 600 h. p. compound engine heaters for an electric railway plant in Denver, and a 100 h. p. heater for the electric light plant of the Toledo *Bee*, Toledo, O. They have just completed for the West End Street Railway Company, of Boston, 20 large corrugated copper expansion joints, two being 20", sixteen 16", and two 12" in diameter. These latter are for the new power station now being built in Boston.

THE ELECTRIC GAS LIGHTING COMPANY, of Boston, has just been loaded down with orders for the never-failing "Samson," as many as 10,000 having been ordered within the last two weeks, so Colonel Burnham says. Six men are employed in the basement packing these giants for shipment to all parts of the United States, while the Colonel sits fanning himself with a Porter & Leavitt motor in his comfortable office above, concocting more such stories. The Porter & Leavitt motor has recently been added to the number of specialties controlled by the Electric Gas Lighting Company for the New England States. This motor is well worthy of special attention by all, and has been designed for use in battery circuits.

THE GOULD AND WATSON COMPANY, of Boston, are having continued success with their moulded mica insulators for railroad work, as evinced by the large demand for their goods. Notwithstanding the fact of there being many other materials in the market, they have supplied the Thomson-Houston Electric Company alone with as many as 23,000 insulators in the past six months, and their last order recently received—in August—was for 2,000 pieces. The West End Street Railway Company of Boston, has just placed a large order with the Gould & Watson Co. for span insulators known as the Brooklyn strain insulator, recently illustrated in the columns of THE ELECTRICAL ENGINEER.

MR. J. F. WHITNEY, 189 Asylum street, Hartford, has been appointed agent for the Germania Electric Company for the State of Connecticut, and is proving himself a good one, having sent in in one month orders for about 10,000 lamps.

MR. W. M. MORDEY, the electrician of the Brush Electric Company, Limited, of London, who is well known by reputation in this country for his valuable work, was a visitor to Boston this week, and favored the Boston office of THE ELECTRICAL ENGINEER with a call. Mr. Mordey reports that his company is beginning to do considerable electric railway work, and he is spending most of his time here in looking up the overhead details of construction. Mr. Mordey, doubtless, would be glad to receive on his return to England, about the 20th of this month, any samples or descriptions of railway details which any of our railway supply houses choose to forward.

MR. F. A. MAGEE, of the Boston branch office of the Engineering Equipment Company, of New York, is becoming quite a familiar figure now in Boston streets, and in resorts of the electrical fraternity. Mr. Magee has been well known to the electrical trade in general for many years, and is working up a good business in the East in general supplies for the electrical trade. Mr. Magee is always glad to see visitors at his office, 126 Pearl street, Boston.

MR. HENRY J. HADAWAY has gone West to join Mr. George Cutter, of Chicago, in the interests of the Germania Electric Company, where he will push the sale of the improved Schaefer lamps. The word "improved" is used advisably, as the Germania Company have recently carefully revised the whole manufacture of their lamps, and are turning out now a lamp superior to all those of their previous manufacture.

THE CONNECTICUT MOTOR COMPANY recently received their third order from the Government for a combination of Connecticut motor and Sturtevant blowers, for use on board the cruiser "Philadelphia." They have already supplied similar installations on board the "Concord" and "Bennington," which have been entirely satisfactory.

PHILADELPHIA NOTES.

MR. C. K. WESTBROOK, manager of the Isolated Department of the Thomson-Houston Electric Co., has recently made the following installations: One 30,000-watt generator to the Pencoyd Iron Works; a 250-light plant for A. B. Farquhar & Co., of York, Pa.; a 250-light plant for Croft & Allen Co.; a 300-light plant for the Omnibus Co.; six small motors for C. F. Langston & Co.; two small motors for the Union League Club; besides numerous smaller installations. Mr. Westbrook has added to his force Mr. Arthur I. Plaisted, who for the past six years has been engaged in the Engineering Department of the Thomson-Houston Electric Co., at Boston.

E. T. ORNE, 112 Randolph St., Chicago, will place his electric speaking tubes in the new *Daily Herald* building of that city, and will use as a part of his system, 100 or more of Partrick & Carter Co.'s new King Annunciators, which he has decided as best adapted to his plans. These annunciators need only to be seen to be appreciated.

MR. THOMAS YEARSLEY, of 123 North Third street, has finished the installation of a 30-arc light plant for the Neshaming Falls Co. There are two miles of wire construction and the plant will light the entire grounds of the pleasure park owned by the above company.

MR. A. H. CHADBOURNE, who for some time past has represented the Westinghouse system of electric railways, recently resigned his position to accept a similar one with the Thomson-Houston Electric Co., with headquarters at 509 Arch street.

MESSRS. CLAY, PEPPER & REGISTER are installing a 500-light plant at the New Century Club on 12th street. It is to be wired with the three-wire system and interior conduits will be used through the building.

ST. LOUIS TRADE NOTES.

THE INTERSTATE COMPLETE ELECTRIC CONSTRUCTION CO. have been incorporated with a capital stock of $10,000; Wm. Wurdock, president, and Chas. P. Lampel, secretary and treasurer. The new company have taken quarters at 809-817 South Seventh street, the buildings formerly occupied by the Heisler Electric Light Co. The company will manufacture and repair all kinds of electrical apparatus and also undertake the complete installation of electric light and power plants, wiring, etc. Their shops are already quite busy with general electrical work, of which they are doing a good deal for the Columbia Incandescent Lamp Co. They are also developing an alternating current motor for light industrial uses. The company has just been appointed general Western agent for the Heisler Electric Light Co., of Philadelphia.

W. L. ARNOLD, the St. Louis agent for the Thomson-Houston Electric Co. has just sold to the Texarkana Gas & Electric Railway Co. a complete installation for 50 double-arc lamps. A 150 h. p. Armington & Sims engine will be put in. Mr. Arnold reports that the new lighting plant of the Arkadelphia Water & Light Co. is finished and n successful operation.

THE POND ENGINEERING COMPANY report increased activity in the territory tributary to their Chicago and St. Louis offices. In addition to the two 400 h. p. Armington & Sims engines now being furnished the Edison station in Chicago, they have just started a 250 horse power Armington & Sims engine in the station of the Cicero and Proviso Electric Railway. This is the second electric railway now in Chicago, both of which are using Armington & Sims engines, furnished by the Pond Engineering Co. They are also furnishing the Murphysboro Water Works and Electric Light Co. with an Armington & Sims engine of 120 h. p; also a complete steam plant for the Grand Ridge, Illinois, Electric Light Company, also one automatic engine, vertical pattern to the Chicago office of the Edison General Electric Company.

THE WESTERN ELECTRICAL SUPPLY CO. are now well settled down to business again and report that they have just closed a contract for the complete installation of the Interior Conduit system for the new *Globe-Democrat* Building. The conduit system will accommodate the wiring for 1,000 lights and also a complete messenger call system and telegraph and telephone wires. Mr. T. J. Wilson, manager of the company, is in the East and on his return will organize a construction company for the purpose of carrying out their contracts.

THE HEINE SAFETY BOILER CO. report the sale of four 200 h. p. boilers to the Denver Consolidated Electric Light Co.; two 250 h. p. boilers to the University of Michigan, Ann Arbor, Mich.; three 375 h. p. boilers to the Chicago Edison Co.; one 150 h. p. boiler to the Thomson-Houston Electric Light Co., Ann Arbor, Mich.; one 300 h. p. boiler to the Dubuque, (Iowa,) Electric Light & Power Co.; and three 250 h. p. boilers to the City Electric Street Railway Co., Little Rock, Ark.

WASHINGTON NOTES.

NATIONAL THEATRE.—The wiring of the National Theatre has just been completed by the contractors, Messrs. Kingsbury & Mustard, of Baltimore, Md. The work has been done in a very thorough manner throughout. The switchboard is a model one in every respect. Pilot lamps, connecting with every circuit in the house, are so arranged over the switch and regulator of the respective circuits that the operator need have no trouble in adjusting his candle-power. The local Electric Lighting Co. supply the current through Thomson recording meters.

CONSTRUCTION BUSINESS BRISK.—The large number of new buildings now being erected have made business for the construction companies very brisk.

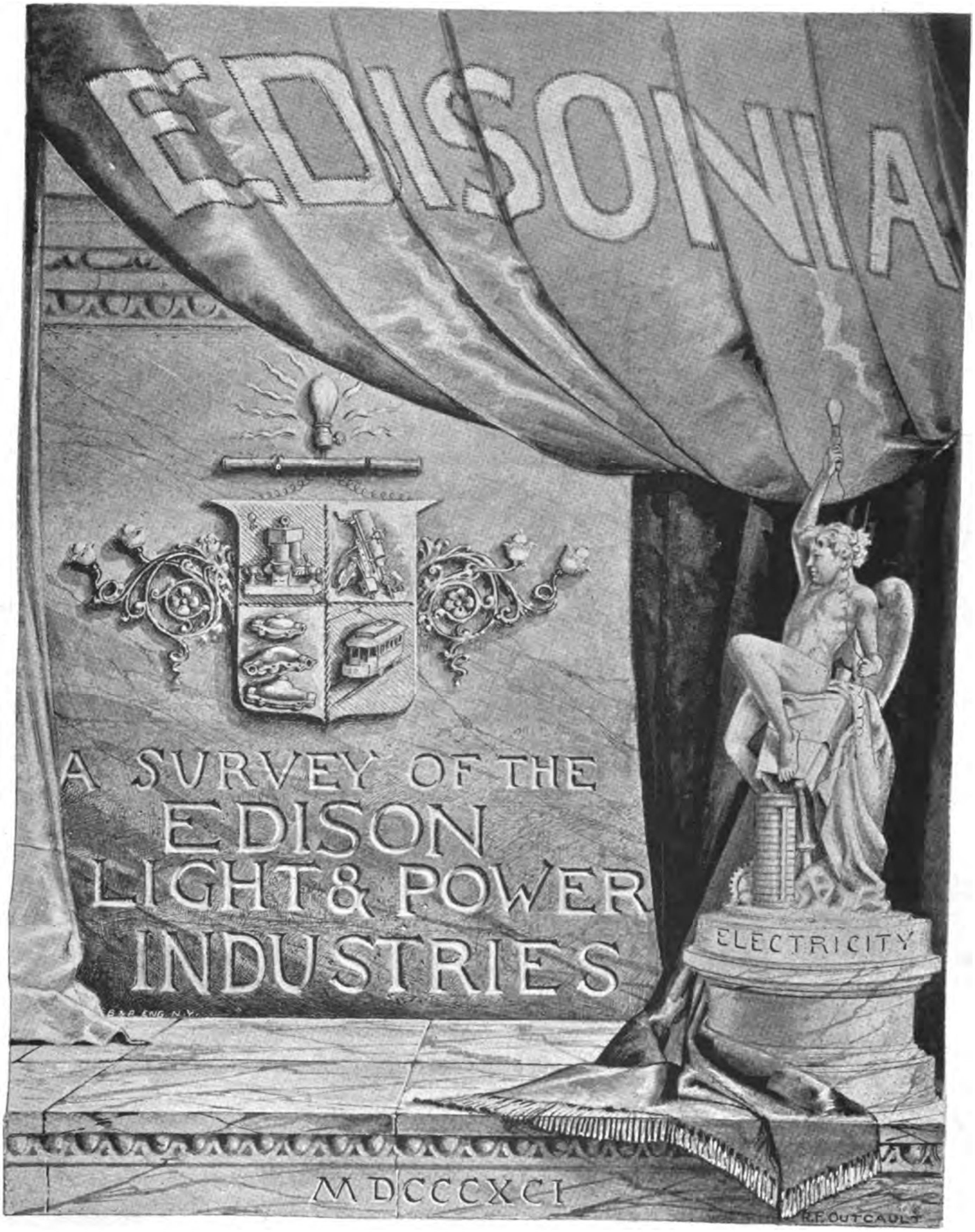
WESTERN TRADE NOTES.

THE SUN ARC LAMP CO., 203 S. Canal St., Chicago, Ill., have greatly enlarged their manufacturing facilities, and are now prepared to fill all orders for the Sun Arc Lamp promptly, either for incandescent or arc circuits. The Great Western Electric Supply Co. have secured the general agency for the West; this lamp has been upon the market but a short time, and it has achieved a phenomenal success, especially among the isolated plants and central stations that have the direct incandescent system. It is simple in design, and gives a bright, steady, white light. The company will also engage extensively in the manufacture and introduction of several new articles, upon which they have secured patents. The company is incorporated with a capital of $300,000.

THE WESTERN ISOLATED LIGHTING DEPARTMENT of the Thomson-Houston Electric Co. report the following sales: Drenberg, Glick & Horner, of the Leader, corner Adams and State streets, Chicago, for a 14,000 watt incandescent dynamo, a one horse power motor and a fan motor; E. Rothchilds & Bros., one 17,500 watt 10 ampere arc light dynamo, to be installed at their place, 203 Monroe street, Chicago; Wakefield Rattan Co., corner Robey street and Blue Island Ave., Chicago, one 400-light incandescent dynamo; The University of Illinois, Champaign, Ill., one 18,000 watt alternating current dynamo and appurtenances for use in electrical laboratory.

CHICAGO ELECTRIC MOTOR CO.—Owing to the large number of requests to repair dynamos and motors, this company, of 205 and 207 South Canal street, have decided to equip a general repair department in connection with their manufacturing business, and will make a specialty of repairing and rewinding armatures of all makes of railway motors, stationary motors and dynamos. They have spared no expense in securing the most experienced men for this department. Having had 12 years' practical experience winding armatures of all systems, they guarantee first-class work and prompt service, at reasonable charges.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***


EDISONIA
A SURVEY OF THE
EDISON
LIGHT & POWER
INDUSTRIES
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R.F. OUTCAULT

EDISONIA.

A SURVEY OF

THE EDISON LIGHT AND POWER INDUSTRIES.

Cover Page Designed by R. F. Outcault.

Sketches of Factory and Office Interiors, and of Fixture Details, by H. D. Gardiner.

Frontispiece and Factories from Drawings by F. King.

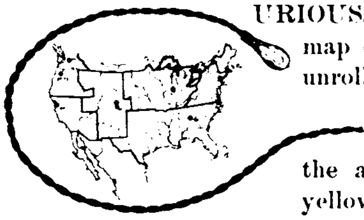
Engravings by Bartholomew & Peckham.

Typography and Presswork by C. C. Shelley.

Supplement to THE ELECTRICAL ENGINEER, N. Y., August 12, 1891.

EDISON BUILDING, BROAD ST., NEW YORK CITY, HEADQUARTERS OF THE EDISON GENERAL ELECTRIC CO.

EDISONIA.



CURIOUS, indeed, and striking is the map of the United States that unrolls before us on the wall. The distinguishing colors that occupy and partition the area are red and blue and yellow as usual, but the divisions are far from conventional. They show little respect for State Rights as embodied in border lines, still less for limitations made by mountain range or river course. At first glance it looks as though the various commonwealths of the Union had merged themselves in a series of huge federations so that instead of forty or fifty States, there were only half a dozen, much to the mental relief of the juvenile student of geography. But the truth is simply, as we discover on closer inspection, that creative and constructive genius has been at its old work once more. Some day, perhaps, it might be a profitable study to investigate the exact nature of the connection between great men and the prosperity of the map-making industry, for it is evident that to the cartographer the achievements of such persons as Napoleon, or Bismarck, or Henry M. Stanley must open up dazzling possibilities of unlimited wealth. Here, at any rate, we have a proof particular of the essential fact, in the map before us, it being that which the Edison General Electric Company has published, to show the eight great districts into which the magnitude of its operations has made it necessary to divide the country, so that its business may be conducted efficiently and successfully.

Nor is it merely in a big map that the vast interests which have grown up around the inventions of Mr. Edison, in electric light and power, find their expression. The fine Edison Building in Broad Street, New York; the sumptuous show rooms and art rooms on Fifth Avenue; the branch offices in Chicago, Toronto, Boston, San Francisco, Portland, Denver and Atlanta; the huge factories in New York, Harrison, N. J., Schenectady, N. Y., and Peterboro, Ont., all tell the story of a growth and development that is unsurpassed in these days of invention and industrial triumph. Out of the trials and vicissitudes and humble beginnings of a bare decade, has come the organization of a business with a capital stock of \$15,000,000 and a gross annual business of nearly the same amount. Even if this were not census year, and, coincidentally, the beginning of the second decade of commercial incandescent lighting, it would repay us to glance a moment at the record of advance and achievement that these figures embrace. Hardly yet can it be said that the unification of the Edison light and power industries which was effected in 1889 has revealed its full measure of benefit and usefulness; but an idea of what it means and of the forces that it controls and has set in motion may perhaps be formed from these pages, exhibiting as they do in detail of pen and pencil the methods and products of the latest electrical arts.

The formation of the Edison General Electric Company not only brought a variety of corporations under one comprehensive management, but massed together a number of offices that had been scattered all over New York City. To-day, within the stately Edison Building on Broad Street, a view of which is shown in the frontispiece, one may accomplish in ten minutes business for which, under the old conditions, a whole day of traveling uptown and down-town was not sufficient. Each of the old concerns, moreover, was conducted as a distinctly separate institution, leading very often to confusion, friction and costly delay; and this state of affairs was not improved by the existence of at least a score of territorial sub-companies and agencies, each in its own way selling Edison apparatus, making contracts for plants and supplies, and carrying on the work of construction. Of course these conditions had sprung up and developed chiefly through the inevitable resort to rough but ready methods of meeting the sudden needs, first here and then there, of a great new industry. But, as in other departments of life and work, the very success of these crude, pioneer plans soon led to a higher evolution of system, and to a broader plane of administration. Without some such unification of interests, it would have become impossible to exercise satisfactory supervision of detail, while those who were entrusted with executive functions would have found their energies frittered away in the mere effort to keep the complicated machinery going. The extent of the change that has been made, and the degree to which the economical simplification of control has been pushed under the present regime will be understood when we state that the entire business of manufacturing, selling and installing is now conducted by the Edison General Company in its own name and through its own employees. One cannot therefore visit the Edison Building without being impressed with the sense of irresistible power that a large, well-knit body in swift, onward motion always arouses. The halls and elevators are thronged, and at every floor one encounters the same bustle and hum of activity. At first, one is inclined to wonder how even a moderate stint of employment can be found for so many hundreds of clerks, but with only ordinary powers of

observation it is easy to see that the difficulty is to get the day's work done within the day. The industry of which these are the headquarters has over 6,000 names on its pay-rolls, and has a monthly income and outgo of a million of dollars. The transactions of its last fiscal year showed an aggregate business of $10,000,000 and the increase is steady. The Company has between 4,000 and 5,000 customers on its books. Its raw material on hand and work in progress often represent a sum of $4,000,000. The aggregate capacity of the large and small Edison stations reaches 1,371,000 lamps, and if to these we add the thousands of isolated plants, we can readily imagine how enormous is the demand for lamps and supplies simply inside what may be called the Edison fold. Then there is the electric railway department with sales of 27,679 horse power of motors and 22,836 horse power of generators in a single year. Then come the newer demands for mining outfits, mill plants, stationary motors large and small, apparatus for electro-deposition of metals, dynamos for supplying telegraph current, electric elevators, etc. All the thousand and one uses to which electricity is now put in this Age of Wire have to be dealt with, and every want is met as promptly as the telegraph and long-distance telephone, reinforcing the efforts of this army of intelligent workers, will permit.

ONE of the features of the growth of New York City has been the invasion of the fashionable Fifth Avenue by trade and commerce. That thoroughfare from Fourteenth Street up to Forty-second is now lined with handsome stores and office buildings, with an occasional hotel or apartment house, and it will not be long before the last of the private residences this side of Central Park will have been given up. In one of the stateliest of the old-time mansions in this new stronghold of business has been established the Fixture and Decorative Bronze Department of the Edison General Co. The show-rooms at 275 are in a sense the lineal successors to those at the historic "Sixty-Five," but unless they are seen it is difficult to realize how novel a departure has been made.* Our sketches will, however, furnish some idea of the attempt to deal with light as an æsthetic element. In this house, whose modernized front has quite a charm of its own, each room has its characteristic or distinctive style of decoration in carpets, tapestry, woodwork, ceilings, fire-places, chairs and other equipments, and then the final touch has been given by showing electric light fixtures in harmonious correspondence. Thanks to this arrangement, he who is building a house or refurnishing one, may come here and see for himself exactly how the lustres or candelabra or chandeliers will look when installed. It is needless to point out the manner in which this facilitates choice or the elaboration of effect. In this room, for example, we may study out the best plan of illuminating a room that the decorator is to treat in the style of the Renaissance. Here we have a Louis Quinze salon, whose brilliancy and delicacy can only be done justice to by the deftest disposition of the light. Or perhaps it is a dining-room that is to be lit up, and here is one we can admire and imitate, noting how skillfully the effects are obtained, and how felicitous Charlotte Bronte's phrase about "festal breadths of light" seems when it is here embodied in a radiance that at once adds to and borrows from the beauty of gleaming plate, sparkling crystal and snow-white damask napery.

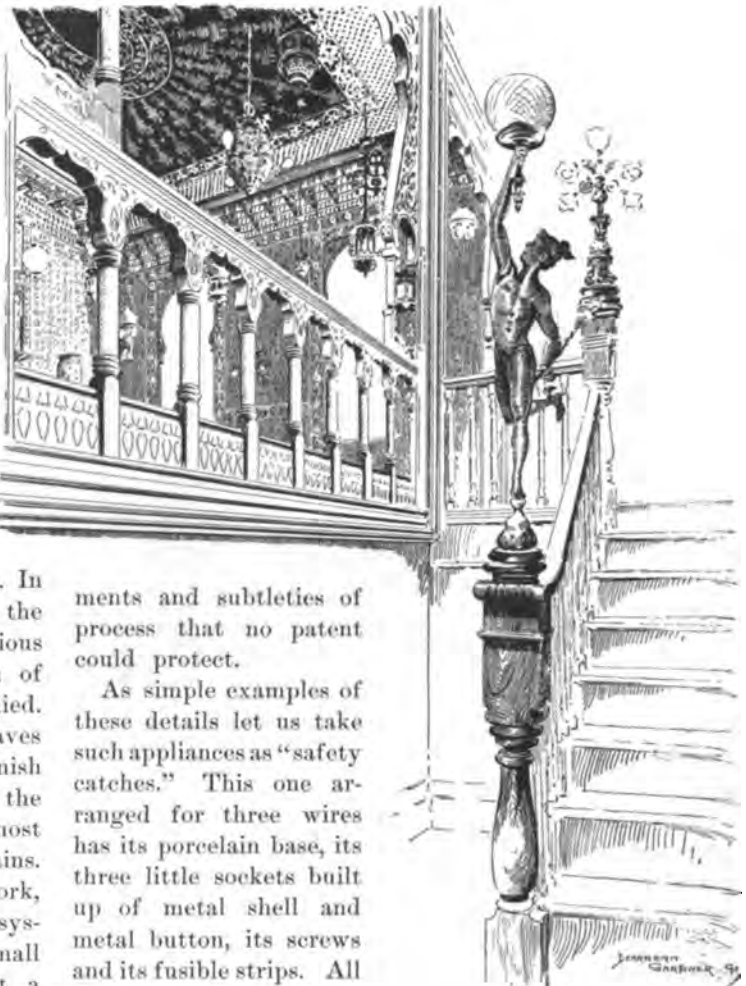
The Edison General Electric Co. long since recognized what we may call the artistic possibilities of electric lighting, and while, as a matter of course, it went into the manufacture of all the ordinary lines of electroliers and fixtures, it made the production of the very highest art work in this branch a matter of deliberate policy. It reasoned that while on the one hand the wealth and culture of the country would now be satisfied only with the most refined and delicate examples of metal work, the taste and ability of the American workman, if given classic and beautiful designs to embody, would be quite equal to the exactions of the most critical connoisseur. How far the Company has succeeded in its aims may be determined not only from the views we have shown of the house it has expressly fitted up at 275 Fifth Avenue, but from the various designs scattered through this text, of electroliers, lustres, trophies, standards, brackets and other special art products. These pieces are first worked out by the Company's own artists, either from the suggestions of patrons or, more often, from their own ideas, and while one may condemn the straining after novel effects that is often seen in such art work in America, there is little here that calls for anything but hearty praise. It has been truly said that one of the charms of the work done by even the humblest Japanese artist is its endless variety and freshness. And so here. Every new production is new, and not a mere stereotype of that which has already wearied us to death by its familiarity or, more likely, by its ugliness. Of course it is difficult in these sketches to give any conception of the glow and sparkle and color of these fixtures and electroliers, but an indication is at least furnished of their grace of outline and delicacy of finish. Here, for instance, is one in which every

line in metal flows in curves as airy and spiral as those of a tender vine, tendril springing above tendril so spontaneously that the whole is a creation of nature rather than of art. In this lamp, with its mellow tint and fine tracery, "the slumbrous light is rich and warm," while in this orbed pendant, the light, as

> "in a globe of film all vaporish
> Swims full-faced like a silly silver fish."

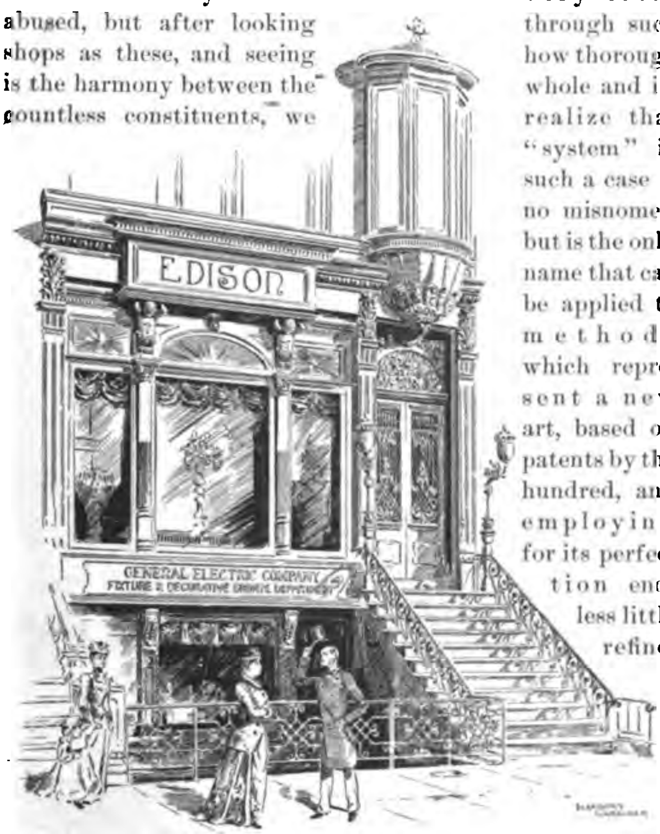
Or in another, a dragon or other fabled monster writhes up a standard and shoots out at us his tongue of fire.

Needless to say, such products demand not only taste in the designer, but skill in the artisan, and it may be doubted whether finer workmanship of the kind is done anywhere in America than at the shops of the Company on East Seventeenth Street and Avenue B, and at Twenty-seventh St. and First Ave.



Stairway, 275 Fifth Avenue, N. Y.

These two shops now employ close upon 1,000 hands. In the larger and older one at East Seventeenth Street, the bulk of the artistic work is done, and there the various interesting processes connected with the production of hammered and oxidized metal pieces may be fully studied. We soon learn that, simple as one of these little oak leaves may look on a very ordinary bracket or fixture, its finish has been reached only after hundreds of blows with the craftsman's hammer, and that in this work, as in most others, the best results are reached with infinite pains. But these two establishments are not limited to art work, for they turn out the detail apparatus of the Edison systems of light and power, as well as the hundreds of small metal parts that go to make up a lamp, or a socket, a switch, or a cut-out. Sometimes one is inclined to think that the word "system" is very much abused, but after looking through such shops as these, and seeing how thorough is the harmony between the whole and its countless constituents, we realize that "system" in such a case is no misnomer, but is the only name that can be applied to methods which represent a new art, based on patents by the hundred, and employing for its perfection endless little refinements and subtleties of process that no patent could protect.

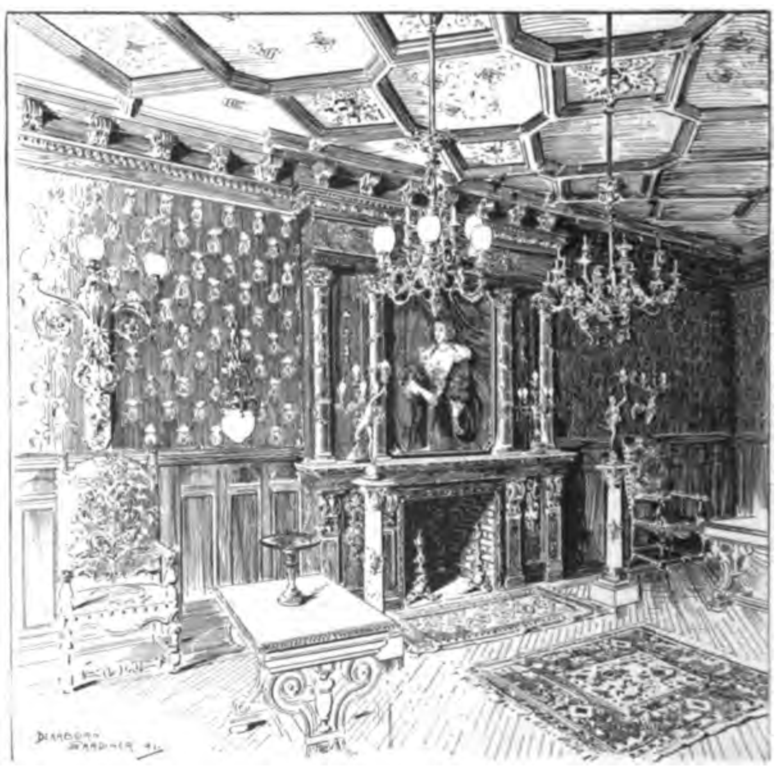


Fixture and Decorative Bronze Department, 275 Fifth Ave., N. Y.

As simple examples of these details let us take such appliances as "safety catches." This one arranged for three wires has its porcelain base, its three little sockets built up of metal shell and metal button, its screws and its fusible strips. All these parts have a definite relation to each other; all have had their conditions determined, and now all are being turned out literally by the million. How easy it seems, as these swarms of boys and men do it. Or, again, take this little switch with its base, its cap, its handle, spring and contact pieces. One could sit here all day and watch the clipping and stamping out and spinning of the various pieces, which pass from stage to stage by the gross. And yet, back of it all, how much of dreary calculation and weary experimenting lies. Simple as these little details are, the essence of the art is in them, and each of them is a necessary consequence of the wonderful step that was made when the incandescent lamp became a success, and yielded its jealous secret to the irresistible attack of Mr. Edison's genius and industry. As when Tennyson apostrophized the "flowers in the crannied wall" and exclaimed that if he could understand them he could know the meaning of all things; so might we, had we but the insight, take these modest, humble appliances and build up the incandescent art again from them in its every adjustment of means to ends.

The manner in which the great modern central stations have affected our notions with regard to interior illumination and decoration is a thing that is by no means clearly understood. And yet, after all, it is only natural that with the improvement in processes of artificial illumination should go hand in hand, a higher perfection in the lamps or the devices employed to hold and display the light. We are here at an immeasurable distance from the lamps made by burning animal fat in the skull of some wild beast slain in the chase, or by palm oil placed in a calabash or a broken cocoanut shell. The primitive lamps in clay or stone or metal were of the simplest construction, but they were steadily improved. It is, indeed, to the lamp that we must look for some of the finest specimens of fictile art, and the graceful productions of the potter's wheel have their match among those furnished also for light-bearing by the skill of the cunning worker in metal. So, too, with candlesticks, candelabra and chandeliers, to which the transition from lamps was easy. To many of these articles historical importance attaches equally with beauty of design, while the forms linger with us in many a fine modification or new application. The introduction of gas seventy or eighty years ago gave a fresh impetus to work in this field, for everybody saw that the beauty of the new illuminant demanded for it a more resplendent setting than had previously sufficed. The manufacture of gas fixtures became very rapidly a great and prosperous industry, giving employment to thousands of skilled workers in metal, and the fact that the gas was one of the chief instrumentalities in the destruction of the fixtures and chandeliers that bore it did not hinder from the production of most gorgeous and ornate works of art. It may be said that we are still within the bounds of the period of gas, for when electricity came upon the scene as an illuminant for interiors its introducers were glad to use such designs in chandeliers and gasoliers as were available, without troubling themselves much about form or comeliness. It is, however, a significant fact, that in the very first fixture wired up for incandescent lighting, the little lamps were reversed so that for the very first time since human beings had used artificial light at all, the lamps were burned "upside down." This was, in its way, as notable and revolutionary a departure as the incandescent lamp itself, for it at once cleared the path for the modern practice of treating light as something fluent and plastic in a decorative way—as something which for artistic purposes in the House Beautiful may be molded and elabor-

Typical Interior, 275 Fifth Ave., N. Y.

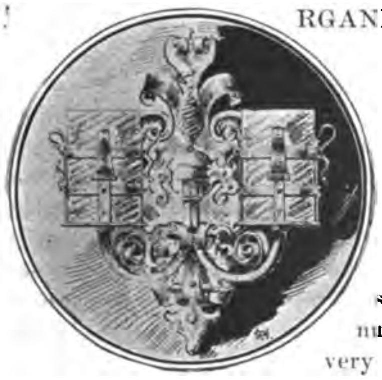


Typical Interiors: Fixture and Decorative Bronze Dept., 275 Fifth Ave., N. Y.

FIXTURE AND DECORATIVE BRONZE DEPARTMENT—MAIN FACTORY, NEW YORK CITY.

FIXTURE AND DECORATIVE BRONZE DEPARTMENT—ANNEX FACTORY NEW YORK CITY.

ated just as freely as though it were drapery or furniture. A lamp no longer has to stand stiffly upright, but, in the words of Dryden, our eyes are gladdened by its "descending excellence," while as becomes that which deserves Shelley's epithet as being "the radiant sister of the day," its very position may be changed with every hour.



RGANIZED in November, 1880, the Edison Lamp Co. began with a force of 55 men. To-day its successor, the Lamp Works of the Edison General Electric Co., at Harrison, N. J., of which an illustration is given herewith, employ some 750 hands, and the number required increases very rapidly, keeping pace with the extension of the incandescent lighting field, which has already become so large that the demand for "renewals" alone is an element in consumption that very few people have any idea of. In fact, the recent great reductions in price by the Edison Company have acted as such changes almost always do, in the way of stimulating and developing the market; and they who operate isolated plants or central stations have learned that true economy lies, not in burning up a big coal pile to render an old, dim lamp partially efficient, but in using only a minimum of current to keep new lamps up to their maximum of brightness. So great has been the growth that the increase in sales of 64 per cent. in 1890 over 1889 bids fair to be far exceeded during 1891, and the consequence is that this huge factory, whose capacity has been brought from 11,000 up to 25,000 lamps per day, is in full swing the year around.

Few more interesting arts can be found than that of the manufacture of incandescent lamps. The painful stages of experiment for fifty years along paths that led nowhither, and the thousands of theories and materials and methods tried by Mr. Edison before he opened the way into a grand new field of electrical utility and made the vital, momentous step from failure to success—all this has become matter of record, and furnishes one of the most fascinating and exciting chapters of modern industrial history. With the recital of that wonderful triumph of insight and perseverance, we need not now concern ourselves, but in our survey of the Edison light and power industries we shall find none more important than this carried on with such vigilant supervision at Harrison. The broad features of the process of manufacture it is easy to describe; into the esoteric details, which are of the kind that every manufacturer keeps strictly to himself, it would be impertinent to enter. The lamp, we note as we go through the factory, is formed from a longish, pear-shaped bulb, narrowing at one end to meet a hollow glass stem. These, on being melted together and filled up at the junction with plaster of paris, become the base of the lamp. The other end of the bulb serves for the connection to an air pump, and after the air has been exhausted by the pump that end is hermetically sealed by melting the glass there so that it forms a little nipple or knob. The chamber of glass has thus become a vacuum in which the "high resistance" horse-shoe or filament of carbon can be brought to the required illuminating point by the passage of the current for hundreds and even thousands of hours without any change in the structure of the filament and without any appreciable deterioration of the lamp from the light-giving standpoint. This filament of carbon is held at its two ends by little conducting wires of platinum which run out through the plaster to similar fine wires of copper. The glass bulb holds on tightly by means of horns or spurs to the plaster base, and this base in turn is capped with a thin metal shell, grooved like a screw, and to which

Putting Tubes on Bulbs for Exhausting.

Unpacking Department.

one end of the tiny copper wires from the filament is brought. The other little copper wire goes to a flat copper button insulated from the screw cap by the plaster. The lamp is now ready to go into a socket, upon turning whose key the circuit can be closed or opened, so as to bring current into the lamp or to shut it off.

This, in a few words and in popular language, gives the general construction of the Edison incandescent lamp, as we see it made, and it will be readily understood that back of such brief, bald statements lie a multitude of intricate details and delicate operations. The mere handling of the bamboo as it arrives in dainty bundles from Japan, tied up in flowery wrappers, and then passes from stage to stage of treatment, becoming small by degrees and beautifully less, until at last it is ready for the carbonizing retorts, involves the employment of many sensitive mechanisms and many lissom fingers; and at each advance towards the production of the finished lamp we encounter a like attention to the minutiæ of the art, of which our casual thumbnail drawings give a noteworthy glimpse or two. We come upon surprises all the time. One's interest is challenged at the very threshold by a gang of boys who spend their time in doing nothing else but unpack the bulbs as received from the glass works and smooth out for use in repacking the countless sheets of tissue paper in which the finished lamps go out. Such a scene would be accepted as quite natural in an orange or lemon grove, but here it strikes upon the fancy with a humorous touch of oddity. Another of our views shows the spacious glass-room where the tubes are put upon the bulbs to be exhausted. The next is the socketing-room, where bases are added to the lamps, making them look like so many transparent egg-shells with julep straws stuck into them. Then we see a bevy of keen-eyed, quick-fingered girls inspecting the lamps after the bases have been put on.

Putting Bases on Lamps.

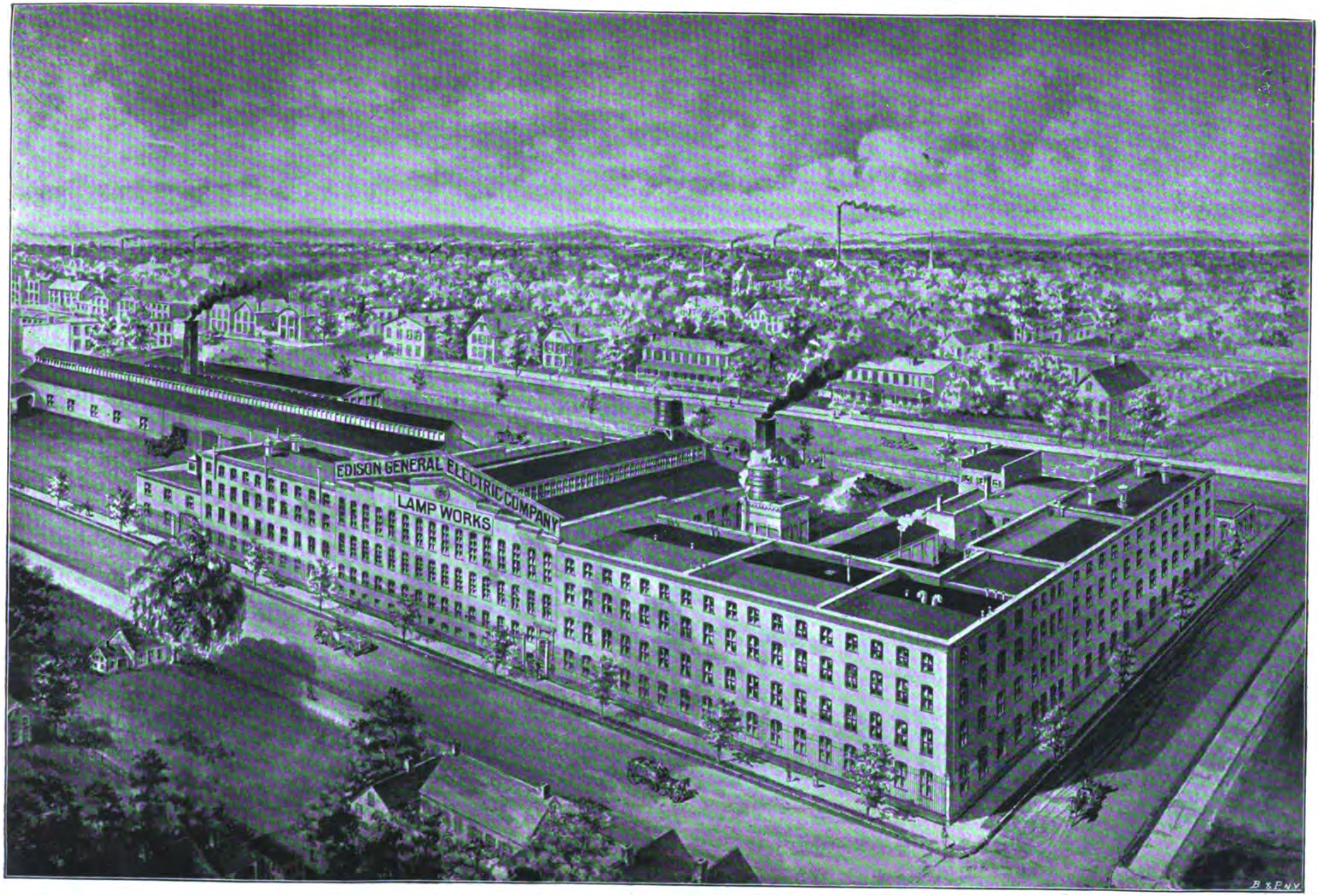
Lamps Ready for Shipment.

Next we come to the spacious packing-room, where the finished lamps are cleaned and inspected. And this inspection, by the way, is no simple routine, or nominal passing muster. Check against check, and a rigid accounting of every defective part, give to the thousands of lamps made daily an individuality of career from start to finish that seems well nigh incredible and impossible. At last, with the lamps, we reach the packing-room, where in huge racks like egg boxes, or in big barrels, they await labeling for the nearest city or for the far ends of the earth.

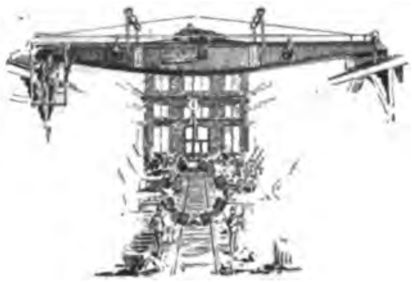
In passing through the lamp works we get a further idea as to the flexibility of methods of incandescent lighting. It is not to be supposed for a moment that the only lamps made are those of 10 or 16 candle power. The remark is still common among unobserving or ignorant people that one of the defects of the incandescent lamp is that its light is always of the same size, whereas larger or smaller lights are wanted. Such critics would be not a little surprised to see what an enormous variety of "railway," "pea," "surgical" and "dental" lamps are here in course of manufacture. The Company has even found it necessary to issue a pamphlet giving full instructions as to the use of small lamps with current from batteries or from a central station. Many of these lamps are also called for to be used on special occasions, and to ornament a dinner table, a ballroom or a wedding bower. Not a few are being used in the construction of signs and words. The lamps are made, too, in a great variety of colors, thus introducing another feature of importance in decoration. Perhaps the most vivid exemplification of what can be done in this way was afforded last year in this city at the Lenox Lyceum, where thousands of lamps in a lofty and graceful Tower of Light were made to glow in time with the pulses of the music, and where long streamers of small colored lamps canopied the whole auditorium, like gay ribbons spanning out from a maypole.

Inspecting Lamps that have been Socketed.

Cleaning and Inspecting Finished Lamps.



INCANDESCENT LAMP WORKS, HARRISON, N. J.



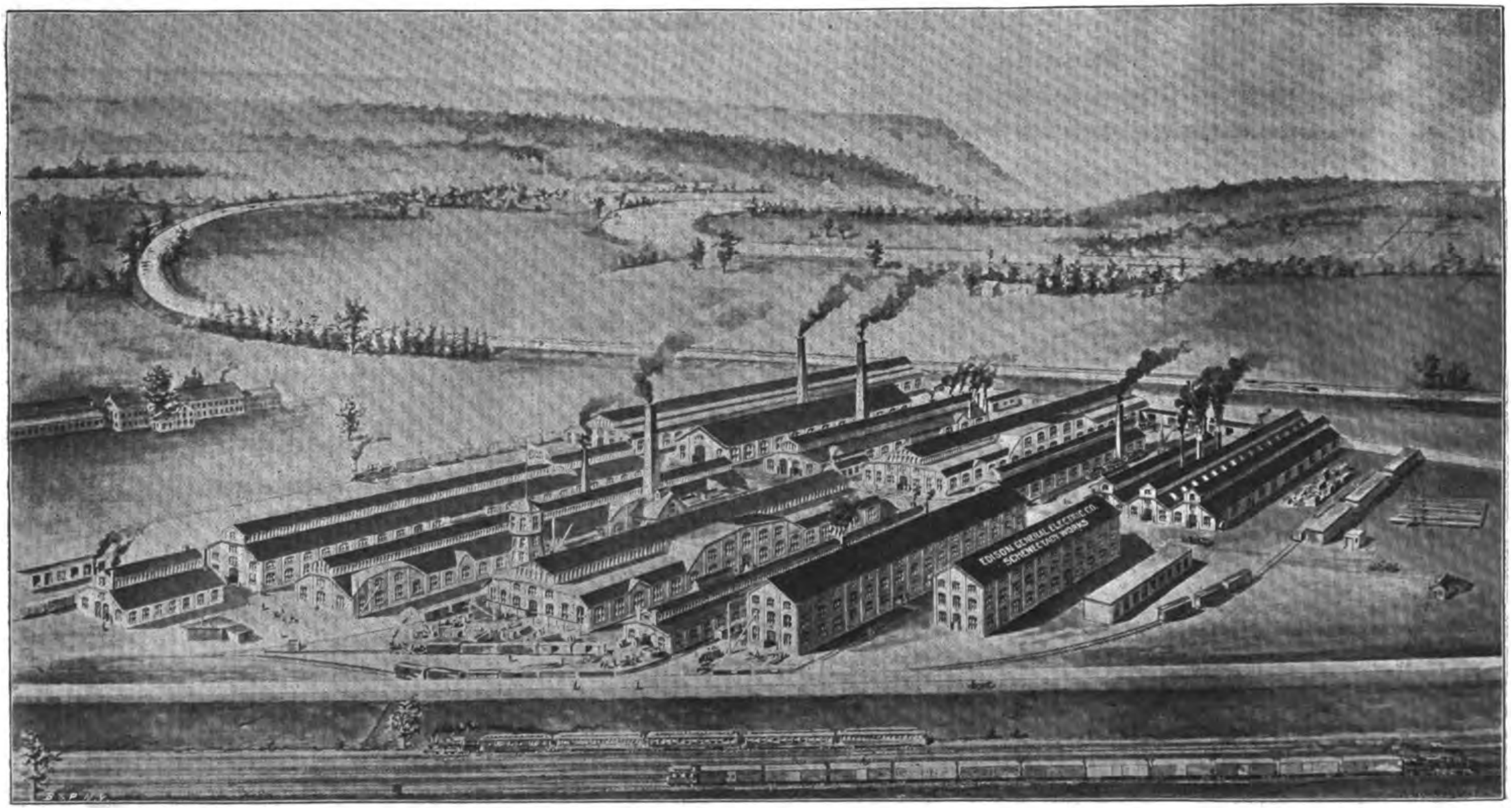
THIS quaint old city of Schenectady, settled so long ago by the easy-going Dutch founders of New York State, might well be renamed Edison, and there would not be in the act other than a graceful compliment to the industries that have brought so much activity, wealth and new life to this quondam Sleepy Hollow of the Mohawk Valley. The Edison Works there went into operation in December, 1886, after their removal from Goerck street, in New York City, with a total pay-roll of 300 men. To-day, only a little more than four years later, there are 3,200 names on the pay-roll—or ten times as many—with the probability that at least 1,000 more Edison employees will have become citizens of the place in a few months. These Works grow with the rapidity of a Western town, for even since the drawing that is here given of them was made—but a month or two ago—they have spread out in every direction, and have lifted up three or four new smokestacks to the sky. This growth is the more extraordinary in view of the fact that several subsidiary but profitable branches of the business that gave work to a large number of hands have been restricted of late to production simply for immediate use on the spot, in order that room might be made for other departments of essential importance.

Assembling a Standard Edison Dynamo.

Though it would doubtless be extremely interesting and instructive to deal with each department of the Works in detail, such an attempt is not our purpose, for only a volume of many hundred pages would suffice for the task. These huge cathedral shops, swarming every one of them with hundreds of busy artisans and filled to overflowing with machines and tools and labor-saving appliances, epitomize the progress to date both in mechanics and in the arts of dynamo and motor construction. If you would find the monument to American skill and genius in such fields, look around you. And as you look, the very first thing that catches the eye is this big traveling crane, which is swinging one of the armatures of Mr. Edison's new multipolar generators. This crane, sliding along so smoothly and so noiselessly is, like all the others, fitted with an Edison motor, and is evidently handled with far greater ease and precision than an ordinary power crane. The current is supplied by means of an overhead wire running the length of the building just above the rail. The operator, as we note, can reverse the direction of the crane or regulate its speed whether for travel or haulage, just as he chooses, by the simple movement of two hand levers on either side of him. Not far away we see another of these cranes assisting in the work of assemblage. A couple of the men are putting together an Edison dynamo of the familiar type, and one of the massive field-magnet cores is being lowered into position on top of the pole-pieces, without the least exertion on the part of the fitters. They merely give a guiding touch or two and the thing is done. All parts of the standard machines, being made to gauge, are interchangeable, and hence the assembly of the machine, though apparently a very difficult feat, becomes in this way, by the resort to such methods, one of the easiest in the world.

We walk into another shop and find a large number of men winding armatures. Some of these armatures are of the Gramme ring type, such as those used in the Edison Company's arc light dynamos; and here is one being wound for a 50-lighter. The ring is about two feet in diameter, and before these men have covered it they will have wound more than 100 sections of wire on it, each section having 50 turns of wire. When it is completed this ring will have on it about 700 wires lying side by side, counting around the periphery, and the weight of that wire will be more than 100 pounds. We ask if the work could not be done by one man. "Oh, yes," is the ready answer, "only one man is needed, but there is a great saving in time and labor in having two men, the one passing the wire over or through the ring to the other, who is waiting for the spool." Elsewhere in one of the other departments we enjoy the pleasure of watching a girl wind a drum armature single-handed, for we see that she is doing good work. Drum winding is certainly easier than ring winding, but the same care and watchfulness is needed throughout. The girl has just about finished the layer of wire on the body, having wound on 28 complete coils. After the first layer is on, the body will be carefully insulated, and the other 28 coils will be wound on. It is easy to see how the wire is built up at the ends around the shaft, all the wires here being carefully separated from one another by shellacked linen. The shellac pot and the linen strips are in front of her, and in her hand the girl holds the fibre rod by the gentle, firm pressure of which she straightens out the wire and coaxes it to lie snugly along the side of the armature. If we wander along into another shop we shall see the workmen assembling street car motors and slipping one of the larger armatures into its place within the fields.

Now we drift into the wire-insulating department, and are face to face with the intricacies and details of yet another great branch of the Edison industries. The Works make insulated wire of all kinds, not only for Edison plants but for a large number of outside customers, and here are rows upon rows of covering and braiding machines in vistas so long that they become dim, and the girls' heads seen against the wheels in the background of the distance look as if surrounded by a close-fitting halo. Some of these spindles



SCHENECTADY WORKS OF THE EDISON GENERAL ELECTRIC CO.

are reeling it off gaily at the rate of 7,000 revolutions a minute, and these thousands of bobbins are dodging around in the giddiest kind of a way, until we wonder that they don't get bewildered and stagger up against each other.

Now and again one of the machines loses the thread of his noisy discourse, but the watchful attendant quietly mends the break, and he chatters on once more vociferously, as if glad to have a womanly ear to tell it to. These machines are marvels of ingenuity, and in some of them the wire goes through pretty well a dozen operations, so that really all it needs when it comes to a rest is a good salesman to dispose of it.

Chatter, chatter, chatter go these busy machines, just like long lines of caged monkeys, and we are fain to escape into the comparative calm of the vulcanizing-room, in which other processes of insulation are going on. Here we see the wire that has been freshly coated with rubber subjected to vulcanization. Steam at the temperature of several Turkish baths is passed into the chamber into which the pans are presently inserted, and each pan contains wire that has been coiled into it for treatment. Near by we get a glimpse of the method of that treatment. Masticators or die boxes are fed with small, flat pieces of prepared rubber, which they chew up with the assiduity of a "boarding-school miss." Within the die box are cylinders fitted with worm thread, which revolves in such a way as to force the rubber compound up to the end at which the die is placed. Wire and rubber pass out together, the adjustment to the wire of the die being such that the rubber lies evenly all around it. The die box is kept at a certain heat all the time, and as the hot wire comes out it is drawn through a trough of cold water, so that the rubber is at once cooled and hardened sufficiently to prevent the wire from sinking out of concentricity by its own weight. The little sketch shows the man coiling the wire at this stage into one of the pans to go into the vulcanizing chamber.

But not even here is there an end of the insulating work done by the Edison General Electric Co. Our guide directs us into another large building where huge caldrons simmer and where huge piles of black iron pipe rise to the roof, for all the world like bundles of exaggerated lead pencils. This is the department in which the Edison electric "tubes" are made. In these tubes is embodied Mr. Edison's method of burying the conductors underground. The tubes consist of long sections of iron pipe, into which are pulled the copper conductors that constitute part of the circuit. Around these conductors or rods manila rope is loosely served, so that when tied up together they make a neat bundle, but in no wise touch.

This bundle is slipped into the pipe, and then when several sections are ready the whole lot is plunged into the insulating compound, which is of a semi-fluid, bituminous nature, and is forced into every interstice under great pressure. With mains and feeders nearly the same methods are followed. When the tubes have been thus treated, rubber plugs are fitted into each end, and the copper conductors stick out four inches beyond the 20-foot section of pipe. The tube is now practically ready for use and abuse. It gets about as much of one as the other, and suffers chiefly from the abuse, owing to the state of the soil in which it is laid in towns and cities where horse cars and gas have had sway, and to the frequency with which modern thoroughfares are dug up or blown up. But it has wonderful powers of resistance, and hundreds of miles in New York, Boston, Chicago, Philadelphia and other cities testify to its success as a solution of what the newspapers call "the underground problem."

Well, what shall we look at next? Here is a vast, airy, well-appointed shop in which has just been begun the manufacture of the famous Siemens cables for all classes of work. Or we will stop awhile in the fine, new power house, about the size of a city central station, furnishing current all day long for the motors that drive every bit of machinery in the Works, as well as for many hundreds of arc and incandescent lamps. In this station there will ultimately be two 130 horse power, two 260 horse power, and two 520 horse power combinations of the Edison direct connected triple-expansion engine and multipolar generator, such as evokes our admiration here. The units for central station lighting and power work are growing bigger and bigger,

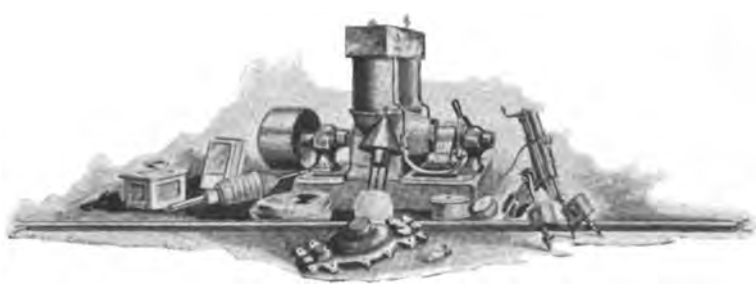
and the tendency is remarkably illustrated in this combination, already in active process of manufacture, both the engines and the generators being built at these Works, for central stations, over a wide range of sizes.

One might thus spend days and weeks observing and studying with curious eye all these details and developments. The most casual glance reveals some new process, and affords some new excuse for lingering. In one corner we chance upon a busy crowd of youngsters fixing up sample cards of wire. By and by we happen into a long gallery and there we see some very demure young ladies splitting mica, although at first glance it looked as though they were amusing themselves with newspaper scraps. Interesting, isn't it? This mica is largely from Canadian mines, and arrives in slabs about an inch thick of various sizes. These slabs are slivered into eight or ten pieces, and then laminated by the young ladies aforesaid. Laminæ one-thousandth of an inch can be obtained, for the girls are very expert and slice it up to the desired thinness with the utmost ease and certainty. They also take the little pieces, such as scraps from commutators, and paste them together with shellac or other varnish, forming sheets of any desired size. In fact, for many purposes these sheets are considered superior to the natural mica laminæ. As will be readily understood, the quality of the mica varies greatly, and hence each consignment is tested to determine that it is up to the standard. After trying a good many things, the Edison Company is quite in love with mica as an insulating material, and in many instances uses it entirely, to the exclusion of other materials, as, for instance, in making up armature bodies. In the commutators, too, mica is used, particularly the pasted sheets, which bend freely; and so securely is the whole pressed together and screwed up, it is very seldom indeed that the commutators suffer from loose or high bars.

In the Tubing Department.

A Corner of the Mica Gallery.

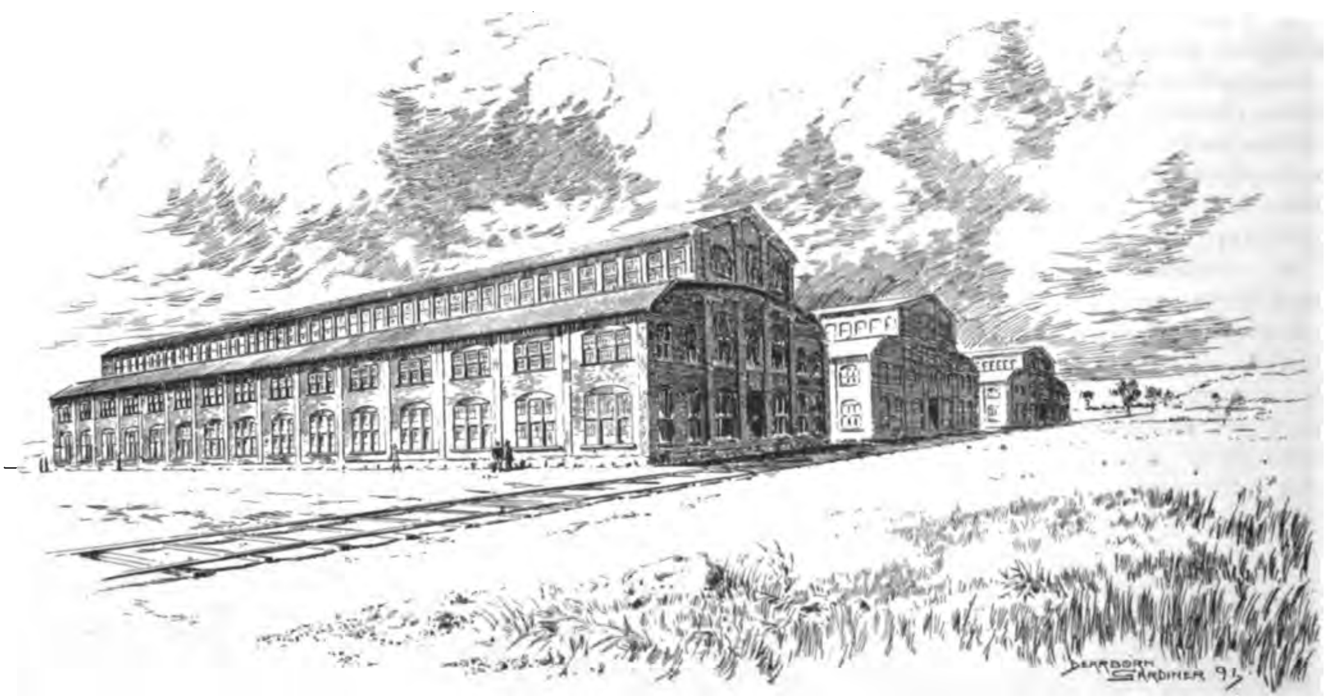
And so we lag and lag, and every time we stop the patient guide gives us notes enough to hang a dozen tales by. For here are testing-rooms for dynamos and motors; tracks for putting street cars through their paces; sections of dirigible electric torpedoes; an electric drill pounding away in a perfectly ferocious manner at the heart of a block of granite that once was proud and obdurate; wood-working shops as large as a furniture factory; suites of managerial offices as solid and imposing as those of a bank; drafting-rooms as big as a billiard hall; a fire-engine station; a locomotive hauling trains of cars all day long to and from the main railroad tracks near by; stabling, store buildings, and minor departments by the score—until at last one begs off on the plea of not being in training for the next six-day walking match, and is smilingly excused from further pedestrianism. There are many things left to be seen, and many well worthy of description, but it is not amiss to break off at a point where the physical fatigue of sightseeing comes in to deepen the impression of magnitude and power already made on the mind. Perhaps only by thus going through such enormous factories can one realize how vast has become the electric light and motor industry. "The greater lies before," no doubt, and yet as one looks back over the past decade, it does seem hardly possible that humble beginnings should have blossomed and fructified so soon in these establishments whose fame has spread through the whole world, and whose products are to be found girdling the earth with ceaseless illumination. When these Works were first projected, the incandescent lamp was treated with suspicion and scorn; but to-day electric light and electric power are alike universal in their triumph and popularity.



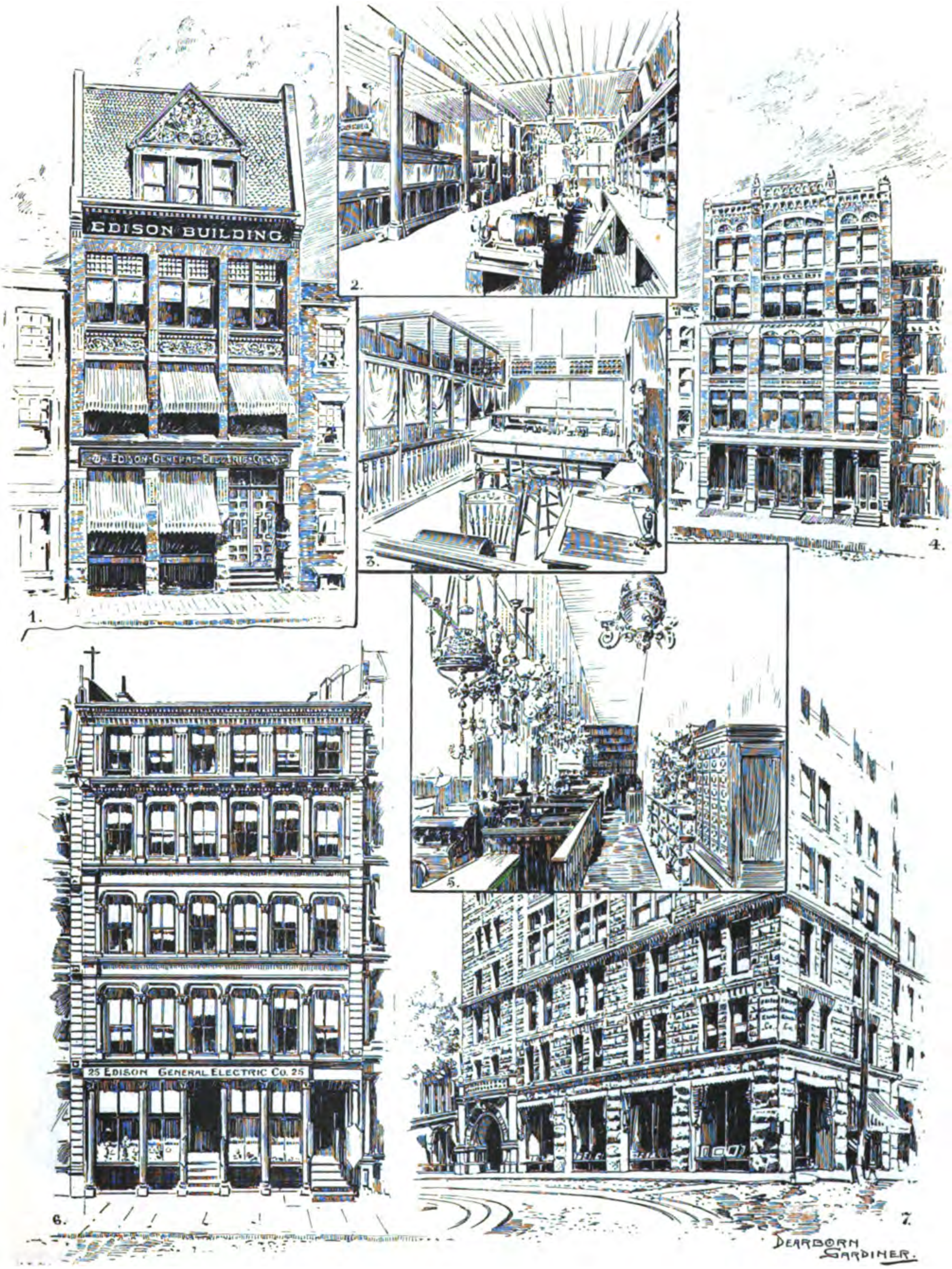
IT IS a well-known fact that Edison lamps and other electrical apparatus are now being made and used all over the world by various corporations, as the result of the exploitation of the patents secured. But in the growing Dominion of Canada, whose relationships with us are already so numerous, the Edison General Electric Co. is carrying on the business itself. From a very small beginning, with only a dozen men in February, 1888, the Company has already come to employ hundreds of skilled mechanics and is now concentrating its productive energies in a huge new factory at Peterboro, Ont. These Canadian Works are in many ways a replica of the vast shops at Schenectady. The property consists of about thirty acres of level ground, and the main building is without a doubt the finest machine-shop in the Provinces. It is 110 feet wide, 272 feet long, with a gallery of 25 feet on each side, and a central height of 60 feet. In it are employed about 400 hands engaged in the manufacture of dynamos; motors for stationary power and electric railway purposes; mining locomotives; underground conductors; various small electrical instruments and appliances; electric cables and insulated wire. When the other buildings are finished, this will be used exclusively as a machine-shop at once, and with that end in view it has already been equipped with a 10-ton traveling crane. Two other buildings, one 50 feet by 272, two stories high; and the other, 50 by 272, one story, are in course of erection, and when finished will be occupied by the wire insulating and cable department. A power station is also in process of construction, with an ultimate engine and dynamo capacity of 1,000 h. p. In the distribution of power the same methods are followed at Peterboro as at Schenectady; namely, all the power is transmitted electrically by means of underground conductors, and each shop is provided with an Edison motor to drive each main line of shafting. This mode of distributing power is at once a great convenience and a great economy, since the motors are entirely automatic and require no attention.

Main Floor, Machine-Shop, Peterboro, Ont.

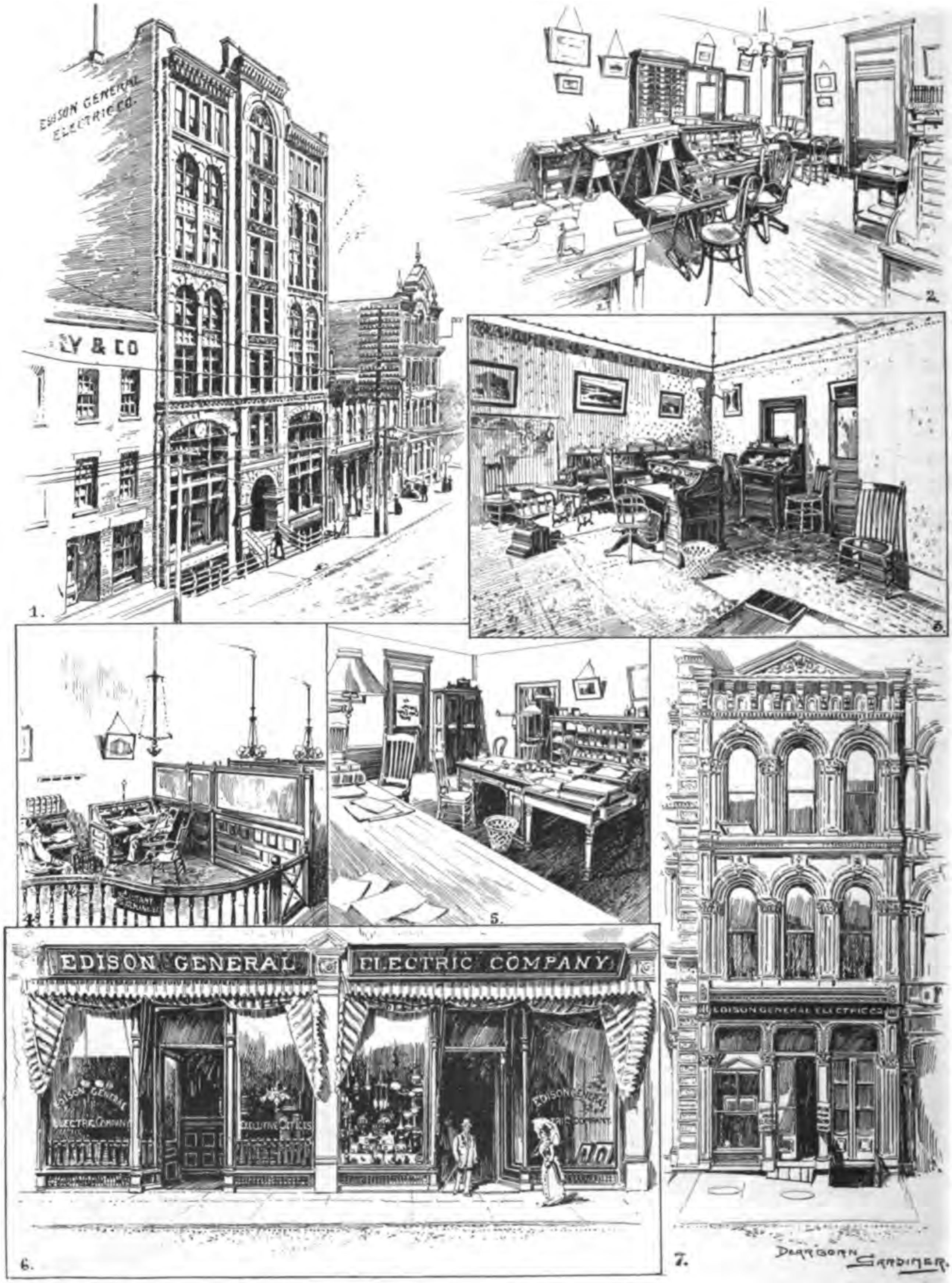
But this does not exhaust the plans. Two new buildings for the lamp factory, two for the carpenter and pattern shops, two for underground conductors, a second machine-shop, iron foundry, brass foundry, office and storehouse are already laid out, and will soon constitute an imposing suburb, with the others, to the prosperous little city of Peterboro. The Works have, moreover, direct railway connections with the Canadian Pacific and Grand Trunk Railroads. These connections are for the exclusive use of the company and unite with four tracks running parallel between the two rows of buildings throughout the entire length of the property—1,800 feet. Besides these steam railway connections there are railroad tracks connecting all the buildings, over which loaded hand-cars may be run to any portion of the establishment. The Dominion may well be proud of this addition to its manufacturing industries.



CANADIAN WORKS, PETERBORO, ONT.

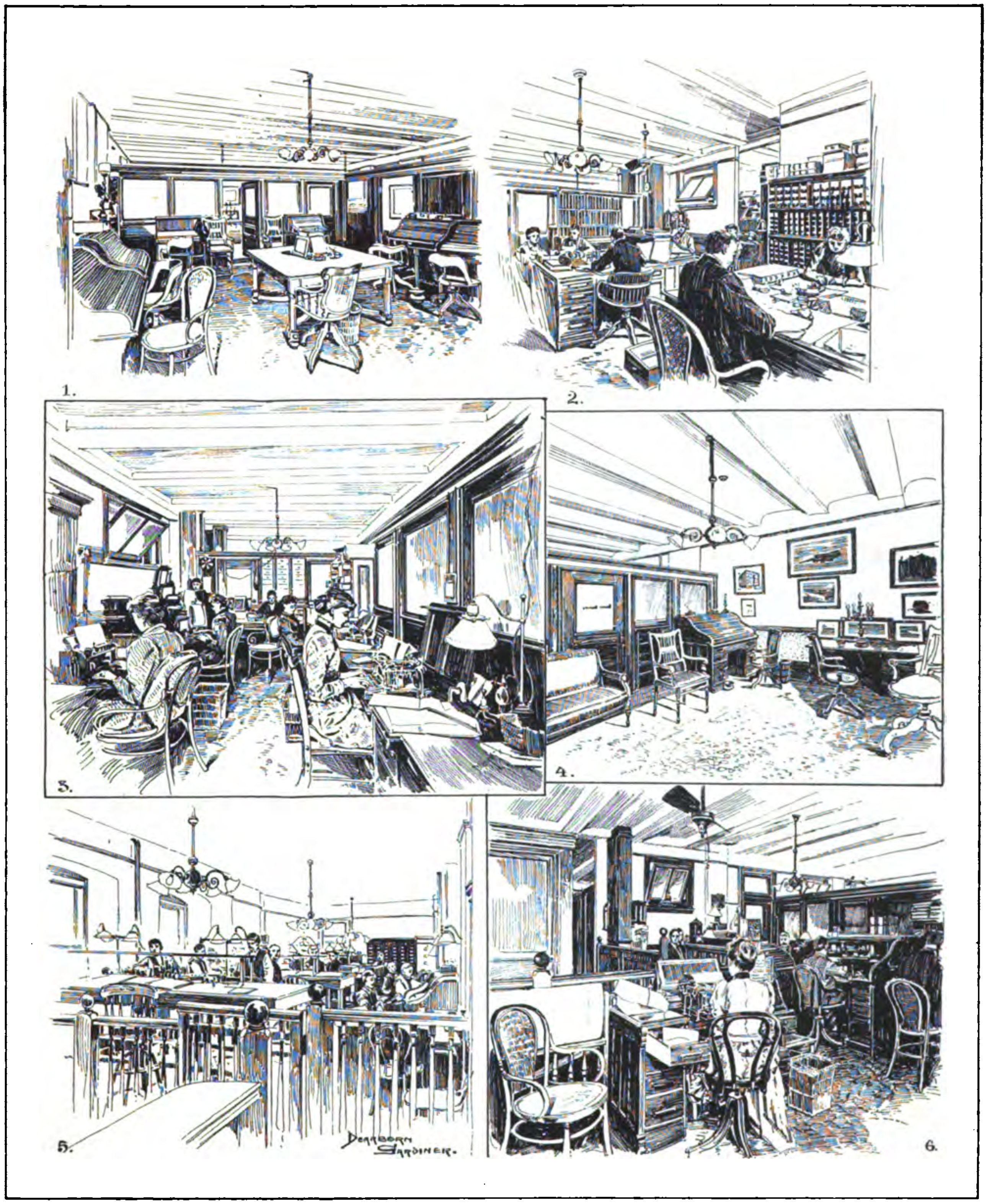


DISTRICT OFFICES: 1 & 3. TORONTO; 2 & 6. BOSTON; 4. CHICAGO; 5 & 7. DENVER



DISTRICT OFFICES: 1, 2, 3 & 5. ATLANTA; 4 & 6 PORTLAND; 7. SAN FRANCISCO

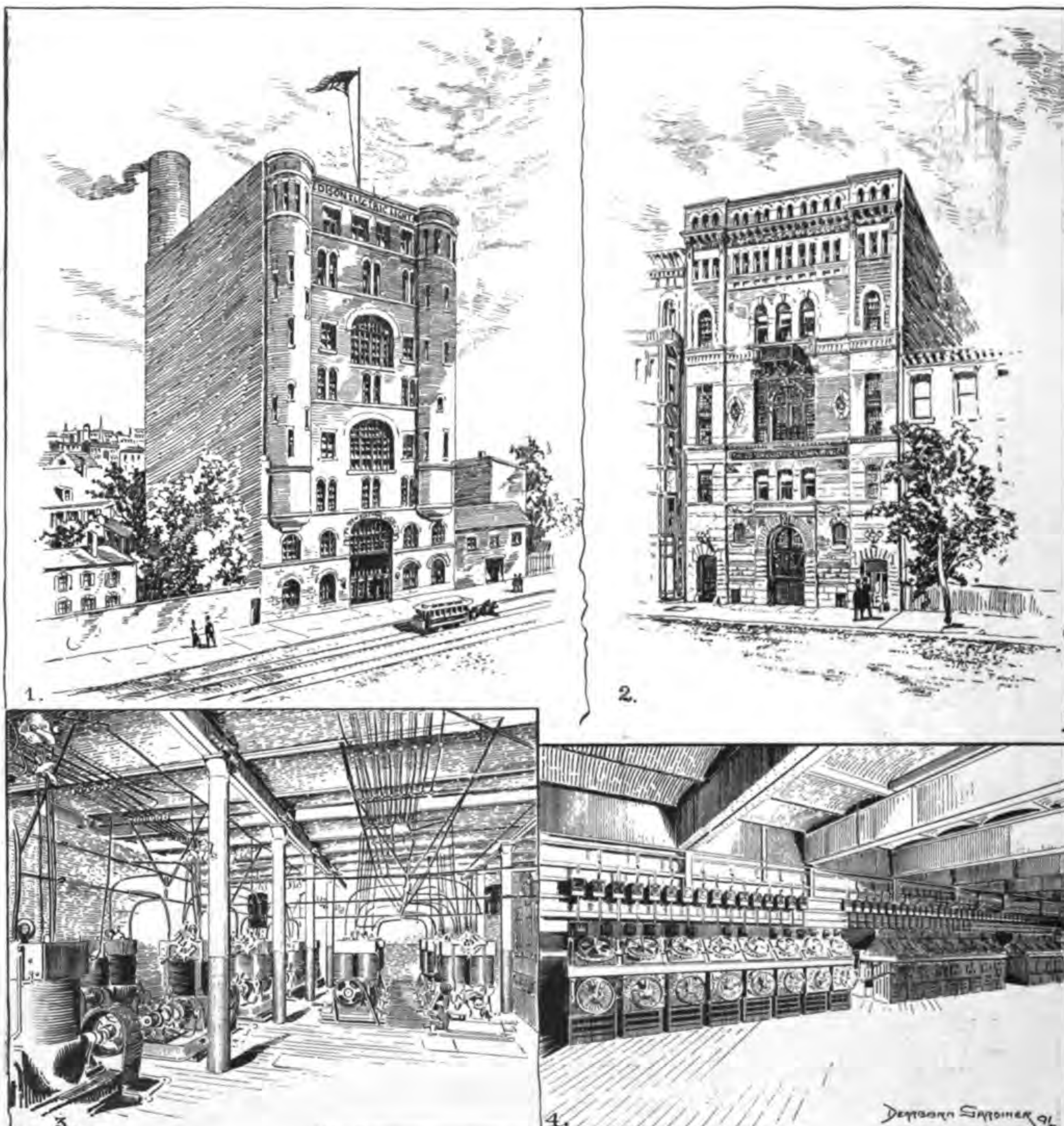
ON an earlier page of this "Survey," reference was made to the fact that the Edison light and power industries had been concentrated, and that the country had been divided up into Districts for greater convenience in handling the



GLIMPSES OF THE EASTERN DISTRICT OFFICE, EDISON BUILDING, BROAD STREET, NEW YORK.

vast business as it comes up. Of these Districts there are eight. Each District is taken care of by a District Manager who has full charge of all routine business within his territory. He has one principal office in his District, where there is an Engineering Department, an Accounting Department, Sales Department, Supply Department and Repair Shop. Depending upon the size of the District, there are a number of local agents, who carry on branch offices in various cities, but who report to the District Manager within whose territory they operate. All dealings with customers are attended to from the District headquarters; all bills are sent therefrom, and all collections are made through the District accounting offices to be forwarded to the New York central headquarters on Broad Street. The Engineering Department of each District has charge of the foremen in that District engaged in construction work, and makes up all estimates, &c. The Supply Department takes care of all renewal orders and miscellaneous supplies of all kinds. The Repair Shop takes care of all small repairs for customers within the District. concerned. Thus all work is despatched with the least possible friction or delay, and the responsibility in every case is easily determined. The District Manager is in direct touch with all the sources from which he derives instructions or supplies of any kind, and knows where to report in any case of emergency or when proposing any new line of campaign.

As will have been inferred, the District Managerships



TYPICAL EDISON CENTRAL STATIONS:—1. PHILADELPHIA; 2. NEW YORK CITY; 3. BOSTON; 4. CHICAGO.

Between the Districts and the executive offices in New York exists a close interdependence. The central authority is exercised through the Executive, Railway, General Supply, Light and Power, Accounting, Treasurer's, Fixture, Wire, Engineering, and Intelligence Departments, all of which have general control over the District Managers, in so far as the business of each department is carry with them no small burden of care. The Managers are like divisional generals actively engaged in the field, and have all the opportunities for the display of the varied ability that such positions imply. And, in fact, the amount of business to be attended to in even the smallest District is very considerable. What it is in the Eastern District can be seen by a glance at the offices of that District, occupying a whole floor in the Edison Building on Broad street. Our sketches of the other offices also show that the Company is very much *en evidence* throughout the country by means of these branches. Some of the District offices are in reality very large electrical depots, carrying in stock vast quantities of material of all descriptions. It may be added here, also, that the Company has an enormous foreign business, handled on the District plan. Part of it is disposed of at the New York headquarters, and part at the large London offices in Victoria street, Westminster.

Pioneer Edison Station.

NEXT to the District Offices as representing the great interests we have been contemplating, and, as a matter of course, far more directly known to and touching the public, come the Edison central stations. Ramified and various as the work is that we have been glancing over, it all dates back for beginning to the demonstration by Mr. Edison of the possibility and practicability of "sub-dividing" the electric light, and is primarily based upon the two new great elements, the incandescent lamp and the central station. Established at first simply to supply a certain number of lights, the central station now generates current in a wholesale way not only for illumination but for heat and power; and the same plant bids fair at no distant day to be as universal a source of supply for the modern citizen as are the great water reservoirs which pour their inexhaustible streams through countless conduits for his benefit.

Of Edison isolated plants there are several thousand, many of them reaching considerable magnitude, with a capacity of from 5,000 to 10,000 lamps, but naturally it is only in the central stations that the merits and beauties of electrical methods of furnishing current for light, heat and power become fully visible. There are to-day in America no fewer than 325 Edison central stations, prototyped in the dingy little shed at Appleton, Wis., and now exemplified by the magnificent buildings in New York, Boston, Philadelphia and Chicago, here illustrated. Such plants show to what a degree of perfection the new art has been carried, and yet are in no sense final, for even now designs are being carried out of others that will far exceed them in splendor of proportions and in refinement of engineering. Not less is this true of many of the new Edison stations for electric railway work, known more specifically by the name of "power house," and requiring many thousands of horse power for car service alone.

Nor is it simply with regard to lighting that these stations have introduced new ideas. Their supply of current for motive power brings us face to face with a new social economy. Electric motors operated from these stations, upon the self-same circuits as the lamps, are now being harnessed to every conceivable kind of work and mechanism; and the end is not yet. In due course the public will become familiar with the fact that it now has power on tap for every purpose, in the largest or the smallest quantities, at every point where it may be wanted, whether for domestic uses, for the machinery of a whole factory, or to lighten the toil of the artisan working single-handed; and the "day load" of a station will be as large as that which now represents the output of a busy night.

WIDE as the range of our survey has been, it takes in only the salient features of a great industry. We have referred but incidentally to the Edison electric railway work, whose totals of investment, mileage, cars and passengers are enormous, and whose success has already led the way in more than one city to the supercession of steam for purposes of urban travel. Then there is the important new department of mill work, as the result of which all the large factories of the near future will depend on electric power. Beyond that again awaits the vast field of electric mining, already broken into so promisingly; while back of these again are electro-deposition, electro-metallurgy and a score of other arts. But be these opportunities what they may, the record of the past and the survey we have thus cursorily made, alike tell us that they will be exploited to the full. It does not need much of the prophetic vision to see that the greatest triumphs of the Edison General Electric Company are those which still await it.

THE

Electrical Engineer.

VOL. XII. AUGUST 19, 1891. No. 172.

THE FIRST TELEGRAPH MESSAGE AND ITS AUTHOR.

THE fact that the Old Timers meet this week in Washington, with the United States Military Telegraph Corps, gives renewed and special interest to the occurrences associated with the sending of the first telegraph message from that city to Baltimore, in 1844. The story is a familiar one in its main incidents, but deserves to be retold in connection with the present interesting reunion. As early as 1838, Prof. Morse endeavored to secure the aid of Congress in the construction of a telegraph line between Washington and Baltimore, and in spite of rebuff and failure he persisted in his application, until, in 1843, it was proposed by John P. Kennedy, of Maryland, to appropriate $30,000 for a series of experiments to test the merits of the telegraph. Even then the scheme met with sarcasm from some and ridicule from others. One Congressman wanted half the sum for experiments in mesmerism. Mr. Houston suggested that Millerism was equally entitled to pecuniary aid from Congress; and Mr. John White, of Kentucky, in the chair, remarked, amid much laughter, that it would require a scientific analysis to determine how far the magnetism of mesmerism was analogous to that to be employed in telegraphs. But at last the bill passed the House and went to the Senate. There it did not encounter persiflage, but the procrastination of the slow-moving upper chamber was perhaps even more dangerous to it. The last evening of the session found it a rank outsider, with 119 bills ahead of it. Morse was a sanguine man, but the situation seemed to him hopeless. With a heart much heavier than his modest gripsack he prepared to return to New York. Meantime his old college friend, Henry L. Ellsworth, then Commissioner of Patents, was doggedly working for the bill in the small hours of the night, and at last he got it through five minutes before the adjournment, only one other measure passing after it. Next morning, March 4, Miss Annie G. Ellsworth, daughter of the Commissioner, hurried to Prof. Morse's hotel to give him the news and bear him away in triumph to breakfast with her father and mother. We can readily imagine the delight with which the despondent, incredulous inventor heard the news, and the pleasure with which he then promised the bright and winning young school-girl that she should send the first message over the wires.

S. F. B. MORSE.

(From a very rare photograph.)

A year later this promise was carried out. The line between Washington and Baltimore had been finished, and Morse had set up his instrument in the Supreme Court, in Washington, while Alfred Vail had the other at Mount Clare depot, in Baltimore. Miss Ellsworth now gave Morse the message suggested to her by her mother, "What hath God wrought," and that wonderfully apt sentence—a genuine inspiration—was sent in triplicate to Baltimore. *It was the first message ever transmitted by a recording telegraph.* The message with Prof. Morse's endorsement is here shown in full, in fac-simile, from the original as preserved by Miss Ellsworth, now Mrs. Roswell Smith, wife of the president of the Century Co. A duplicate of it is in the possession of the State Historical Society at Hartford, Conn.

Through the courtesy and assistance of Mr. W. W. Ellsworth, the secretary of the Century Co., we are enabled to accompany this brief account of two very dramatic and memorable incidents by portraits of the participators in them. The engraving of Mrs. Smith has been made from an admirable miniature on ivory, painted at the time of these occurrences in Washington. In view of her early association with the telegraphic art and her ardent interest in Morse's success, it seems to us that the Old Timers could not do a more graceful thing during their present meeting in Washington than to toast Mrs. Smith and elect her an honorary member of their organization.

ANNIE G. ELLSWORTH, NOW MRS. ROSWELL SMITH.

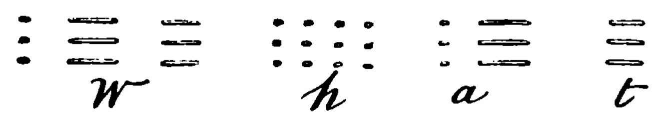
(From an ivory miniature painted about 1844, by Freeman).

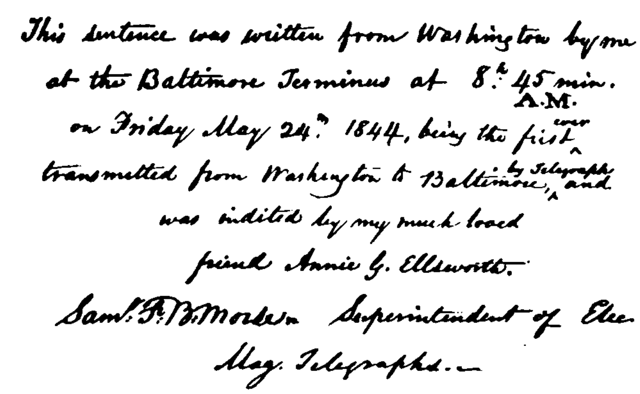
A word or two about Mrs. Smith's father, the Hon. Henry L. Ellsworth, will not be out of place. He was of New England birth, twin brother of the Hon. W. W. Ellsworth, at one time chief justice of Connecticut, and son of Oliver Ellsworth, third Chief Justice of the United States. He graduated from Yale College as a member of the class of 1810, and it was there that he made the acquaintance and friendship of Morse, who was his classmate. After farming at Windsor, Conn., and practicing law at Hartford, he was appointed a commissioner to the Indian tribes of the Far West by President Jackson, who later made him the first Commissioner of the U. S. Patent Office. This office was created in 1836, and he was its incumbent until 1845, when he resigned. Prof. Morse was extremely fortunate in having such a man as a personal friend, for Mr. Ellsworth was not only distinguished by birth and culture, but by great energy and executive ability. While to-day it might seem a little singular to have the head of the Patent Office actively lobbying on the floor of the Senate for a struggling inventor, there can be no doubt that his action at that time was considered entirely free from impropriety, and that but for his zealous work during the crowded closing hours of the session the introduction of the telegraph might have been deferred many years and Morse might have suffered the fate of many other deserving inventors.

HENRY L. ELLSWORTH, AS A CLASS MATE OF MORSE, AT YALE.
(From a miniature on ivory).

HENRY L. ELLSWORTH, FIRST U. S. COMMISSIONER OF PATENTS.
(From an old daguerreotype).

This act of friendship to Morse was not the only public service of this talented man. As already mentioned, he dealt with the difficult questions connected with the relationship between the Government and the Indian tribes, and his attitude toward "Poor Lo" may be gathered from the fact that Washington Irving accompanied him on one of his tours of investigation. As the first head of the Patent Office he did magnificent work in organizing the new Agricultural Bureau, that has since developed into a great department, represented in the President's Cabinet. He was one of the earliest to recognize the value of, and to invest in, the prairie lands of the West; and it is believed he used the first mowing machine introduced there. But while, as has been said, "the patience, enthusiasm and industry of Mr. Ellsworth in this work entitle his name to the grateful remembrance of the American farmers," it is not less true that his disinterested support of the great inventor in the hour of trial must ever secure for him, with his daughter, a warm place in the affection of the telegraphers of America. It is with no small pleasure that the editors of THE ELECTRICAL ENGINEER present in this issue these portraits, now published for the first time, and tell again, though briefly and inadequately, the ever memorable story of the first message.

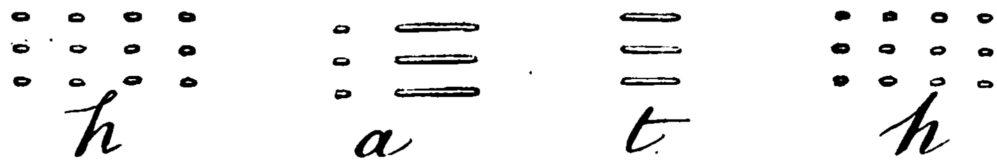




This sentence was written from Washington by me at the Baltimore Terminus at 8h. 45 min. A.M. on Friday May 24th 1844, being the first ever transmitted from Washington to Baltimore by Telegraph, and was indited by my much loved friend Annie G. Ellsworth.
Saml. F. B. Morse Superintendent of Elec. Mag. Telegraphs.

FAC SIMILE OF FIRST MESSAGE, NOW IN POSSESSION OF MRS. ROSWELL SMITH.

With regard to the portrait of Morse, it may be stated that it is taken from a very rare photograph in the possession of F. W. Jones, Esq., of the Postal Telegraph Co. The familiar portraits of Morse show him much later in life, with a full, flowing beard.



THE WORK OF THE U. S. MILITARY TELEGRAPH CORPS.

BY

Madison Buell

I.

TO what and to whom can the greatest credit be given for the favorable termination of the civil war?

Setting aside the military skill of the commanders of our armies and the bravery of the men who composed them, a close observer of the events of the war can only come to one conclusion—that steam and electricity, and the men who manipulated them, were the greatest factors, and that without them the destruction of the Union would have ensued.

At the time of the attack on Fort Sumter, in 1861, the entire military force of the Government was some 16,000 regulars, principally employed in the West to hold in check marauding Indians. The first call for troops by the President was for 75,000 men; the second call, in May, 1861, resulted in bringing into the field, by July 1st, over 230,000 men, and on the 1st of December, 1861, the entire strength of the army, both volunteers and regulars, was 660,970 men. Steam and electricity were the great agents utilized for the gathering, concentration and distribution of this army of unparalleled magnitude, and the enormous supplies necessary for its subsistence, and in no other way could it have been done in so short a time.

It was the telegraph that bound the loyal States together and stimulated civil and military authorities to greater exertion by the almost limitless contributions of men and money. It was in truth an electric nerve that united them, consolidated their power, inspired them with courage and hope and *and finally led them to victory.*

As an illustration of the marvelous facilities of steam and electricity as the great saving factors in the war, let us take the battles of South Mountain and Antietam. During the battle of Antietam the following message was sent to Halleck, at Washington:

Please take military possession of the Chambersburg and Hagerstown railroad that our ammunition and supplies may be hurried up without delay. We are in the midst of the most terrible battle of the war—perhaps of history. Thus far it looks well, but I have great odds against me. Hurry up all troops possible. Our loss has been terrible, but we have gained much ground. I have thrown the mass of the army on the left bank. Burnside is now attacking the right. I hold my small reserve, consisting of Porter's Fifth Corps, ready to attack the centre as soon as the flank movements are developed. I hope that God will give us a glorious victory. GEO. B. MCCLELLAN,
Maj.-Gen.

A mental photograph of this incident, taken at the time, would reveal in the telegraph office of the War Department at Washington the faithful military telegrapher at his instrument; and standing within hearing of the "click, click" of its armature, Lincoln, Stanton, Halleck, Eckert and others with their hearts beating rapidly. We can see them even now, men of wisdom, men of action, men pale with care, and men weary with the burden and responsibilities of a nation's welfare. All is hushed—the silence is like nightfall, broken only by the mournful beats of the instrument's armature, as if in sympathetic realization of the dreadful import of its magical sound waves. "We are in the midst of the most terrible battle of the war—perhaps of history." The head and advisers of a great nation endowed with such a range of vision as to enable them by the aid of the strange and "fierce electric fire," drawn as it were from the edge of a midnight storm, almost to see the battle's progress and hear the cannon spit out their iron wrath!

The evening's gray twilight descended upon the battlefield with its twenty thousand ghastly dead and wounded, and the telegrams were deluged with the tears of the mothers and wives of the slain and wounded. You could almost hear the heart's anguish ooze out of the words as they were recorded. Instead of the peaceful orders for daily wants as now, they were like the following telegram sent the night after the battle of Antietam.

To the Chief of Ordnance,
Washington:

If you can possibly do it, force some twenty-pound Parrot ammunition through to-night, via Hagerstown and Chambersburg, to use near Sharpsburg, Md. GEO. B. MCCLELLAN,
Maj.-Gen.

Let the mind grasp the incident for a moment—a general, after a day of bloody battle, surrounded by his killed

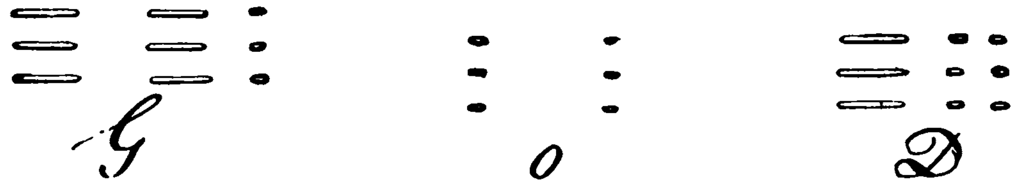
WITH GEN. MCDOWELL.

(From an Old Engraving).

and wounded, writes his telegram and orders his deadly supplies for the morrow's battle with as much assurance as we now order our daily marketing by the same means. Do not the two telegrams of McClellan furnish a wonderful amount of mental food for digestion and reflection in the way of illustrating the fact that steam and electricity were the saving factors of the Union?

II.

But what of the men—the bone and sinew of the whole military telegraph system? Twenty-five years or more ago they presented a long line of rippling glory for deeds



of bravery and faithfulness. To-day few are living—the rest—

> "On Fame's eternal camping-ground
> Their silent tents are spread;
> And Glory guards with solemn round
> The bivouac of the dead."

Some one has said that the world knows nothing of its greatest men; and that there are forms of greatness, or at least excellence, which "die and make no sign;" heroes without the laurel, and conquerors without the triumph. This is strictly applicable to the men who composed the U. S. Military Telegraph Corps from the date of its origin up to the present time.

The formation of the United States Military Telegraph Corps, in 1861, might readily be termed a meteoric electrical aggregation of men, beginning as it did under such men as the late E. S. Sanford, of the American Telegraph Company, and the late Col. Thomas A. Scott, of the Pennsylvania road, and Andrew Carnegie at its head, with young David Strouse as its first superintendent.

This aggregation, starting with those named, and D. Homer Bates, W. J. Dealy, James R. Gilmore, Madison Buell, Richard O'Brien, Jesse H. Bunnell, C. A. Jacques, H. W. Benton, Wm. Tinney, W. B. Wilson, Jesse Crouse and others as telegraphers, gradually increased at Washington, the West, and Southwest, until, at the close of the war, there was gathered a body of men unsurpassed for skill, and bravery, and faithfulness, who to this date have not received from the Government any official recognition of the invaluable services rendered as great and undisputed factors in the preservation of the Union. The remnant of the brave corps are still besieging the doors of Congress with olden-time vigor for the just recognition of a military status at the time of their service. So far it has been denied, and yet Congress could manage in ten years to increase the pension appropriations from $50,000,000 to $124,000,000. For military telegraphers of the civil war "republics are ungrateful."

The first superintendent of this corps was young David Strouse, who went to Washington with Col. Scott and Andrew Carnegie.

Young Strouse (peace to his ashes) so taxed his energies during the first part of the war that at the end of six months his life's work was done. David Strouse entered upon the scenes of the war impelled by the highest sense of duty to his country; he was found equal to its weight, and did it worthily. "Command was service; humblest service done by willing and discerning souls was glory," and David Strouse obtained it.

Of Andrew Carnegie, the messenger boy of the early days of telegraphy, and now the great iron king and millionaire, what can be said of him that has not already been published in a thousand and one forms?

Those who were so fortunate as to meet him in the early days of the war can now walk "along the pebbled shore of memory" and build up, at pleasure, their recollections of the events and his association with them.

III.

It is impossible to give in a short description even a faint conception of the character of the men who first organized the Military Telegraph system. Col. E. S. Sanford, president of the then American Telegraph Co., supplied money and material nearly a year for its support and maintenance. For its more perfect organization, however, the credit belongs solely to two men, the late Gen. Anson Stager and General Thomas T. Eckert, now General Manager of the Western Union Telegraph Co. Gen. Stager was appointed Captain and A. Q. M. of Vols. 11th of Nov. 1861, and Thomas T. Eckert received an appointment as Major and A. Q. M. July, 1862. Gen. Stager's headquarters were at Cleveland, Ohio, and Major Eckert was assigned to the Department of the Potomac. The value of the Military Telegraph was in a way recognized by Secretary Stanton in his official report to Congress Dec., 1863, as follows: "The Military Telegraph, under the general direction of Col. Stager and Major Eckert, has been of inestimable value to the service, and no corps has surpassed, few have equaled, the telegraph operators in diligence and devotion to their duties."

At the fall of Richmond, April 3, 1865, after announcing the fact, from the office window of the War Department, to the assembled multitude beneath, Secretary of War Stanton turned to the operators in the room and said: "Boys, I consider the telegraph my right arm, and if ever I can do anything for you, don't hesitate to ask it."

It is now August, 1891; the "boys" are still besieging Congress for a recognition. They have followed Stanton's advice, "don't hesitate to ask." The "boys" are still asking, and are sadly realizing "With what a heavy and retarding weight does expectation load the wing of time."

In June, 1864, Eckert's field telegraph was a marvelous success. Superintendent Doren built and took down an average of twenty five miles a day. All corps headquarters and many brigades were kept in constant communication with Grant's and Meade's headquarters during every engagement. Every reconnoissance made in force had telegraphic connection with headquarters, and yet notwithstanding the acknowledged vital importance of the Military Telegraph on every occasion, the "boys" are still following Stanton's advice, and are knock, knock, knocking at the Uncle Sam's bronze doors of the Capitol.

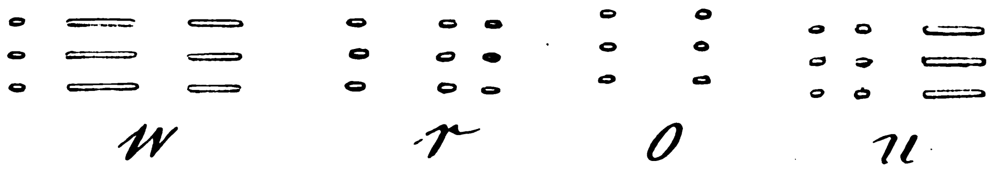
The Comte de Paris in his history of the Civil War says:

> "A single example will show the importance of the Military Telegraph. Without counting the lines in existence of which possession was taken, the employees of the Government constructed five thousand kilometres during a single year of the war, and they forwarded nearly one million eight hundred thousand despatches; and sufferings and dangers were not spared those whose merit was the greater in that it was less conspicuous. More than one among them, shivering with fever in an unhealthy station, lay down with his ear against the instrument to write with a trembling hand under dictation some important despatches, whose secret he would confide to no one. Many paid with their lives for their boldness in setting up their instruments under the very fire of the enemy, and one fact, almost incredible, bears testimony to the dangers to which they were exposed. During the siege of Charleston the wire which connected the besieging batteries ran so close to the rifle pits of the Confederate skir mishers that it was frequently cut by their balls."

IV.

It has been described how McClellan relied upon the military telegraph at the battle of Antietam, and perhaps another illustration of its immense value will prove interesting as well as instructive, bringing in as it does President Lincoln and Gen. Hooker, in conversation over a wire at a critical time in the affairs of the nation.

Lee's victories on the Rappahannock in 1863 produced in his army a spirit bordering on enthusiasm, and it was in better discipline than ever. Their commissary department was, however, in such a deplorable state that supplies were



an absolute necessity, and Lee determined to strike Pennsylvania. In less than two weeks he drew Hooker's army away from the Rappahannock to the upper Potomac. On his way Lee cut all the telegraph lines which connected Washington with Winchester and Martinsburg, and their loss was a serious one.

D. H. Bates.
(*From a War Time Photograph*).

The Washington authorities, as usual, were anxious about the safety of Baltimore and the capital. In the conversation that took place over the wire between Lincoln and Hooker, the former remarked: "If the head of Lee's army is at Martinsburg and the tail of it on the plank road between Fredericksburg and Chancellorsville, the animal must be very slim somewhere. Could you not break him?" Hooker replied, "that to proceed to Winchester and have him make his appearance elsewhere would subject me to ridicule."

Honest Lincoln! How shall we ever separate the fine silken threads of feeling and loyalty that were woven in your character from the fabric of quaintness and jest, or even know where one ended and the other began? I shall never forget the time in the War Department office when little Tad Lincoln stuck his fingers in the ink and walked down alongside the row of marble tables upon which our instruments were, and rubbed ink all over their tops as he went along. The writer seized him by the seat of his little pants with one hand, and with the other his collar, and walked him Spanish fashion back to the door. It suddenly opened and we were confronted by his father. It was a regular surprise party and no mistake. Mr. Lincoln looked at the writer, and the latter held up little Tad's bedaubed fingers and pointed to the marble-top tables. Lincoln burst out laughing, and taking the little youngster up in his great, long arms and hugging him closely to his breast, left the room with a jolly laugh and on a run down the hallway of the Department.

All offices of the Military Telegraph, however, did not have marble-top tables—quite the contrary, as Manager Dealy, of the W. U. Tel. Co., New York office, can testify. No doubt he often contrasts his present quarters with those he occupied near Darnestown, Md., in 1861—a pigsty—gorgeous in all its slime and filth, roofed in by blankets for protection against rain and cold.

V.

Every man in the Military Telegraph Corps from the Department of the Potomac of the extreme Southwest had within him that "independent spark from Heaven's bright throne"—courage—which enabled him to do his duty under the most trying circumstances. Some one has said that the brave man is not he who feels no fear, which would be stupid and irrational; but he whose noble soul its fear subdues, and bravely dares the danger nature shrinks from—and in confirmation of it, let me give one or two illustrations:

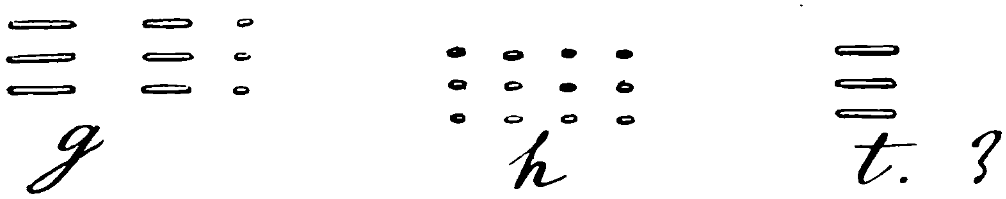
The battle of Mechanicsville was fought June 26, and that of Gaines' Mills, June 27, '62 Jesse H. Bunnell was the military telegrapher with Gen. Porter, and during the retreat lost his way. Porter falling back, formed in line of battle near a telegraph line, which vital fact Bunnell discovered in trying to get back to the right road.

Bunnell cut the wire, connected his instrument, sat down by a tree, called up McClellan's headquarters, and the ever-faithful telegrapher Caldwell answered.

It is well known that to be a great man it is necessary to turn to account all opportunities, and McClellan did so. Bunnell was furnished with mounted orderlies, and for hours he sent and received messages as to the progress of the battle. Plum in his admirable history of the Military Telegraph tells of this heroic incident and also of that of young Nichols; and let me say here that this invaluable book should be in the hands of every telegrapher in the country. They would then know the kind of material early telegraphers were made of.

A. B. Chandler.
(*From a War Time Photograph*).

Bunnell sat behind the tree, and "the roar of contiguous cannon, the crack of musketry, the Federal cheers and Confederate yells, added to the bursting of unnumbered



over-shot shells, and the zip-zip of bullets and the solid shot crashing through the trees," were not favorable to telegraphing by ear, but Bunnell was one of the best telegraphers in the country, although in his teens.

Several times Porter telegraphed for reinforcements. Longtreet and Hill were not easily shaken off. At 2 P. M. Porter telegraphed for aid, and Slocum's forces came across the river. An hour later other troops were crossed to the rescue; though Porter now had 35,000 men, he was hard pressed. At four o'clock Jackson had come to help Hill and Longstreet. Then Ewell fell upon Porter. The carnage was awful. It seemed as if nothing human could withstand it. Bunnell's orderlies were brave fellows. Several of the messages he handled were spattered with their blood, and he was obliged to forward his telegrams to Porter by two or three couriers, as several were shot on their way.

More troops were required and more answered the telegraphic call. McClellan was fighting the battle by telegraph.

Bunnell's action is no bright and illustrious illusion. It was an occasion which called forth the utmost power, vigor, and activity of the nature of a beardless youth. It was an act of heroism which showed a noble soul, subduing fear and bravely daring the danger which nature shrank from.

Is it a marvel that McClellan appreciated the Military Telegraph? Is it a wonder that Stanton considered the telegraph his right arm.

It is a great pity that some of Bunnell's telegrams, bespattered with the blood of his messengers, could not be placed upon the desks of the members of Congress as souvenirs—a sort of bloody reminder of the claims of telegraphers.

VI.

The other incident is also told by Plum:

Telegrapher Nichols, with Gen. Sumner during the retreat from Seven Pines to Harrison's Landing, opened an office at the top of a telegraph pole, which Gen. Wilson and himself constructed out of hardtack boxes piled one on top of the other. Cutting in on the wire, Nichols maintained communication with McClellan for hours after dark. To see to write he had a lantern, which made an excellent mark for the enemy, notwithstanding which he kept the office open till ordered closed by Sumner.

It was a critical and dangerous position, and Nichols was only another illustration of a soul that "bravely dares the danger nature shrinks from."

VII.

If the telegraphers showed courage and bravery in the field, others who were not there during the whole period of service performed their service—their duty—to the Government just as faithfully as though they had stood in the front rank of battle. Eckert, Bates, Chandler, Tinker, and others were shining examples of the men who were at Washington, struggling with difficulties that those in the field little knew the anguish required to surmount.

"In a fair gale every fool may sail, but wise behavior in a storm commends the wisdom of a pilot," and Major Thomas T. Eckert, who was at that time manager of the Military Telegraph for the Department of the Potomac, could be said to be the pilot who gave out his energy in proportion to the resistance it met. He took control at a time when everything had a gloomy and terrifying representation. His position was delicate and difficult. He introduced new ideas and greatly enlarged the scope of the system. Aware of the toil and hardship to be endured and the blood likely to be shed, he gave words of hope, confidence and commendation to his men. His great ability, ardent zeal and patriotic devotion seemed to cover and penetrate the system of every man within the department, and one might figuratively say, with truth, that the mountains, hills, rocks and glens of difficulties were swept away by that spirit of "enthusiasm which, like the leaping lightning, is not to be measured by the horse-power of the understanding.'" These are not sycophantic words, but impressions of memory "that dance without wages or compulsion."

GEN. T. T. ECKERT.
(From a War Time Photograph).

Naturally, Major Eckert relied upon the skill, judgment and fidelity of his men both in the field and at his own headquarters for the carrying out of his own ideas and the execution of his plans. At the end of the war their devotion, fidelity and courage proved to him that they had made for him and themselves "a name and place among the nations of the earth," with this exception, however, the name shines so brightly as to make the shadow so deep that the Congressional eye in America has not been able as yet to penetrate beyond the shadow. D. Homer Bates, A. B. Chandler, Chas. A. Tinker, Dennis Doren and others were men who were possessed of an energy and a perseverance that were as remarkable as great. There was but one sentiment prevalent among them, a stern and unrelenting determination to do all in their capacity to secure such success. They did their work well and without a thought of fame.

VIII.

What has been said applies equally to the men comprising the whole Corps, for those spoken of fitly represent the body. After four years of arduous service, through the East, South and Southwest, a period marked by courage and fortitude, unsurpassed even by the soldiers in the field, the noble band of men returned to their homes without a single word of official recognition, save in one instance. Gen. Eckert, as Assistant Secretary of War, presented to Messrs. Bates, Tucker, Chandler, Caldwell, Doren, Baldwin, Stewart, O'Brien, Sheldon and Buell, as souvenirs from the War Department, silver watches that had been purchased and used to establish uniform time in the Army of the Potomac, marked "United States Military Telegraph."

This recognition was given to these few of the most prominent men in the Department of the Potomac.

Outside of this and some words of appreciation and commendation, no other recognition has ever been given.

All that remains to the surviving members of the Corps, they who linger yet awhile for "Death—the black camel which kneels at the gates of all"—is the sweet satisfaction that comes from the consciousness of duty faithfully performed.

ELECTRICAL ENGINEERS.

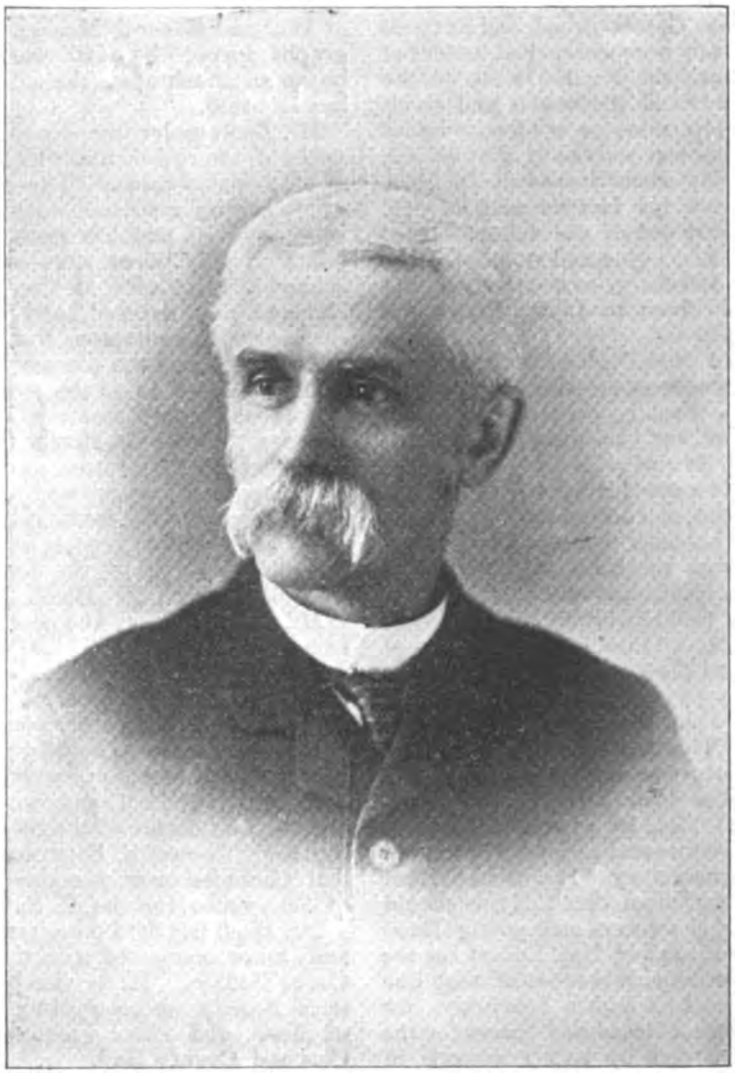
MADISON BUELL.

Madison Buell, one of the oldest telegraphers and electricians in the world, in point of years of service, was born at Lebanon, Conn., July 31, 1834. His experience as a telegrapher is almost as old as the invention itself, for it was only seven years after Morse patented his invention that Mr. Buell entered as a messenger boy the Buffalo, N. Y., office of the New York, Albany and Buffalo Telegraph Company, the first business telegraph company established.

The Buffalo office was opened in the basement of the Mansion House July 3, 1846, and Mr. Buell entered the office in February, 1847. After serving a few months as messenger, he learned the art of telegraphy upon the cumbersome machinery in use at that time. The lever of the register had three steel points for embossing the Morse characters upon the paper. A bell was attached to the side of the register which would ring whenever the clock-work of the register revolved, the latter being set in motion by the movement of the armature of the magnet in response to distant signals.

The relay magnets in use at that time were enormous affairs; one was composed of eight coils four inches in diameter and about ten inches long, of about No. 18 cotton-covered wire saturated with gum shellac. It weighed nearly one hundred pounds. During lightning storms the armature frequently stuck to the iron core of the magnets, and the office ruler was generally used to pry the armature off the cores of the magnets.

Mr. Buell's progress in telegraphy was so rapid that in the month of November, 1847, he was the operator at Niagara, C. W., now Niagara-on-the-Lake; and in 1849 was operator at Niagara Falls, N. Y.



MADISON BUELL.

As a pleasing incident in his early telegraphic life, he remembers enjoying there the almost constant companionship of Henry Clay, the great Whig statesman, who, after seeing him transmit his telegrams for Lexington, Ky., would take him by the hand and they would go over to Goat Island together. The eminent statesman would, after reaching the rapids between the first Sister Island and Goat Island, change his clothing, the young telegrapher doing the same. Ropes were then tied around their bodies and the ends attached to the trees on Goat Island, and hand in hand the two would wade across the rapids between the two islands. The water was remarkably low, about six or ten inches in depth. After returning to Goat Island, Mr. Buell distinctly remembers following Mr. Clay under the beautiful cascade that falls between these two islands, both reaching by this novel passage the first Sister Island.

From 1849 to 1857–58 Mr. Buell was connected with the New York, Albany and Buffalo Telegraph Company, and was chief operator at Buffalo for the Western Union Telegraph Company on the Eastern division.

At the breaking out of the war, in 1861, Gen. E. S. Sanford, president of the then American Telegraph Co., at New York, wired him to come on and go with him to Washington in connection with telegraphic service for the Government. Baltimore being in the hands of the rebel mob, the two men were compelled to take the steamer "Maryland" at Perryville, Md, and go to Washington via Annapolis. At Washington he found Andrew Carnegie in charge of the railroads and telegraphs, under the direction of Thomas A. Scott, of the Pennsylvania Railroad Co. Mr. Buell remained on duty in the War Department office until just previous to the movement of the army across the Potomac into Virginia, when he was assigned for duty with Capt. Carlisle, of the regular army, whose headquarters were at the important post of Long Bridge.

After the army moved across the bridge into Virginia, in May, 1861, he was assigned for duty with Gen. Irwin McDowell at Arlington Heights, and again with Wilcox and Heintzelman at Alexandria, Va.

The day before the battle of Bull Run, July 21, 1861, he was ordered to Fairfax Court House as telegrapher for Gen. McDowell, opening communication with McDowell's army by a line of mounted couriers from Fairfax Court House. After McDowell's futile efforts to stay the defeat of his army, and the major portion of his army had retreated by way of Fairfax Court House, the General and his staff, escorted by a company of cavalry, halted in front of the military outpost about 3 o'clock Monday morning, July 22.

McDowell seated himself alongside of young Buell and began writing messages to the Secretary of War and Lieut. Gen. Winfield Scott, while his Adjutant General, Capt. J. B. Fry, sank on the floor, and resting his head on the General's knee, fell asleep. They had been in the saddle over forty-eight hours and both men were thoroughly exhausted. As fast as McDowell wrote his messages, young Buell transmitted, word by word, following every movement of the pencil. McDowell was so worn out mentally and physically that he fell asleep with pencil in hand, so that Buell was compelled frequently to nudge and arouse him with "What next, General, they are waiting for you?"

The scene at this early hour in the morning was an impressive one; the straggling army in full retreat, Capt. Fry and the rest of the staff stretched upon the office floor, and Gen. McDowell, with a bullet hole through the crown of his cap, resting his head upon the office table, and only arousing when spoken to or when the click of the telegraphic instrument had ceased.

This was the scene at Fairfax Court House, but what occurred in the office at the War Department can be learned from the vivid description of the thrilling scene in Plum's History of the Military Telegraph.

In May, 1862, young Buell was ordered by Col. Stager to Strasburg, Va., with a locomotive and telegraphic supplies for the military line in the Shenandoah Valley. The trip was made on the Manassas Gap Railroad, and at times the engineer, fireman, and Buell were compelled to crawl on their hands and knees into the tender to escape the bullets of the guerillas who infested the woods and stealthily fired upon passing troop-trains or wildcat engines passing over the road. He had just arrived at Fort Royal, intending to remain over night, when Stonewall Jackson, the Confederate General, made his famous raid on Gen. Banks, driving the latter's army out of the valley. Buell succeeded in escaping with his engine and supplies. His brother Henry, stationed at Strasburg, was captured and carried to Richmond and confined in Libby Prison for months.

After McClellan commenced the "Peninsular Campaign" telegraphic communication was kept up with his army by the lines running north from Washington to Wilmington, Del., and thence over the military telegraph line which was built in February, 1862, down the Delaware railroad to Salisbury, Md., and on the turnpike by way of Drummondtown to Cherrystone Inlet, and across the Chesapeake Bay via a 28-mile submarine cable, which was at that time the longest in America. From the time that McClellan began his operations upon the peninsula until the time that the hearts of the American people were filled with gratitude by the great message that "the Confederate capital was repossessed and connected telegraphically with Washington," it was the main artery of communication between the commanding generals and the War Department.

After the battle of Seven Pines McClellan fortified himself with great care, and his future movements were awaited with feverish anxiety by the War Department. Telegraphic communication with him, by reason of frequent interruptions of the Delaware line and the want of proper railroad facilities, was not satisfactory. It was important to the Government and to McClellan that this line should be of the most trustworthy character, and young Buell was selected by Secretary Stanton and Maj. Eckert for the post of honor and assigned as superintendent of that line June 25, 1862. He was furnished with a locomotive for private use upon the Delaware railroad and horses for the turnpike. The line was guarded by two regiments of soldiers.

Before leaving Washington Mr. Buell asked Secretary Stanton the question, "How long will I probably be required on the Fortress Monroe line?" The Secretary of War replied, "Until Richmond is taken." The answer not being quite definite enough, Buell ventured once more with the remark, "Have you any idea, Mr. Secretary, how long that will take?" The Secretary of War raised his eyebrows, looked at Buell for a moment, and then answered, "In about six weeks, I hope." Mr. Buell, in relating this incident, says it was the longest six weeks he ever experienced, and that often the "gleaming taper's light" of hope shed its increase of brightness, only to be followed by what more than once bid fair to be the last flicker of a dying flame. He was in charge of this line nearly four years!

How well Mr. Buell performed the duty assigned to him during the time he was in charge of this, the most important of all the Government telegraphs, the official letters he holds will fully testify, and they are documents of which any man may well be proud.

After the close of the war Mr. Buell was assistant superintendent of the Western Union Telegraph Co., Philadelphia, under Mr. Bates, and afterwards called to New York by Gen. Eckert, who was general superintendent of the Eastern division.

In 1868, Cromwell Fleetwood Varley, the celebrated English electrician, made an exhaustive and comprehensive test of the condition of the Western Union Telegraph Co.'s lines from New York in every direction. Varley's report was a startling revelation of the miserable condition of the company's wires. Gen. Eckert recognized the immense value of this revelation, and with the same characteristics that made him the invaluable Assistant Secretary of War and General Manager of the U. S. Military Telegraphs during the civil war, grasped the situation and began an attack upon the evils under which the company was laboring.

Mr. Buell under the direction of Gen. Eckert began a series of improvements, which in a few months bore fruit of incalculable value. The relay magnets in the various offices having resistance varying from 500 to 2,500 ohms were removed, and low resistance coils introduced. Old joints in line wires were cut out, new ones made and soldered. Batteries at the principal main offices were changed and reduced, and the whole service bounded forward with an impetus that seemed miraculous.

Mr. Buell was the pioneer in this work, and caused reports to be sent in to the general superintendent's office, stating the exact working of all lines previous to the changes. After the changes were made the various managers and chief operators were constantly forwarding the most congratulatory messages. They were at first skeptical in regard to the contemplated improvements, and were chary of favorable reports until fully convinced that the splendid working of the lines were really due to the changes made by Mr. Buell.

Mr. Buell made all the changes, embracing the territory from New Orleans, to Plaister Cove, N. S. It was during this period that he invented and introduced the universal switchboard now in general use throughout the United States and probably other countries.

No patent was ever applied for, the two-year limit for the application of a patent having expired.

In 1876 Mr. Buell was recommended by the Governor and the Legislature of the State of Delaware, and also by the Hon. Thomas F. Bayard and the three U. S. Centennial Commissioners, for the position of Superintendent of Telegraphs for the U. S. Centennial.

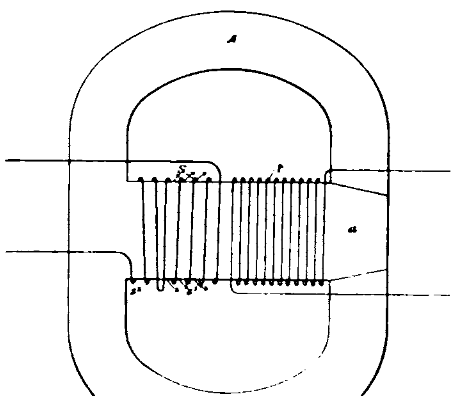
Mr. Buell has held important telegraphic trusts for years and is now connected with the Western Union Telegraph Co. at Buffalo. He is vice-president of the Buffalo Electrical Society and consulting electrician for the Academy of Music and other prominent buildings, including the City and County Hall.

He is and has been a frequent contributor for years to the daily press on electrical matters. A short time ago the Buffalo *Sunday Courier* published for some months a series of war articles written by him, which attracted general attention and were widely quoted.

His papers read before the Buffalo Electrical Society are numerous, the "Geni Electron," "Aerial Navigation by Electricity," "A Trip to the Moon," being the prominent ones, and copied more or less by the press of the country. His last paper, "The Electrical Utilization of Water-Powers," received general recognition here and abroad, and many applications are being received for copies. He is in frequent receipt of requests from publishers of leading magazines for articles from his pen, and it is evident that his whole electrical career furnishes material of a most valuable and interesting nature, not merely for occasional articles, but for a volume.

SPENCER'S SELF-REGULATING CONVERTER.

In certain forms of converters the primary and secondary coils are placed side by side upon a soft-iron core. When currents traverse the primary coil, lines of force are generated which thread the secondary coils and develop therein an electromotive force, which in turn establishes current in the secondary coil, if its circuit be closed. The lines of force developed by the flow of primary currents for the most part complete their circuit through the iron core;



Spencer's Self-Regulating Converter.

but in practice some of them escape through the air and thus do not thread all the convolutions of the secondary coil. In practice the number of lines thus escaping is greater as the current flowing in the secondary is greater, so that at full load the number of lines of force actually threading the secondary, and consequently the effective, electromotive force developed therein is less than at small load.

It is this effect which is utilized by Mr. Thomas Spencer, of Pittsburgh, Pa., for governing the converter and causing it to maintain a constant, or even increased, potential at full load. He carries this out in practice by placing upon the core s, in the accompanying illustration, a few convolutions of secondary wire, s^2, wound in the reverse direction from the main portion s^1, and in locating these convolutions so that the escaping lines of force do not thread them. From this construction it results that when but little current is flowing in the secondary, and consequently but little opposition is offered to the flow of the lines of force through the core, practically all these lines of force thread both the main and the reversed secondary convolutions. The effect of the reversed convolutions is therefore to neutralize an equivalent number of the main convolutions. The consequent effective secondary electromotive force developed is the resultant of the two opposing electromotive forces in the two sets of convolutions. If now the resistance of the secondary circuit be diminished and more current be permitted to flow, then more of the lines of force will complete their circuit outside of the iron core, and thus fail to traverse the reversed secondary convolutions. The reversed convolutions will no longer neutralize the same number of main convolutions, and the resultant secondary electromotive force will therefore be correspondingly increased.

The relative proportions of the two sections s^1 and s^2 may be varied to obtain different degrees of compensation or amounts of regulation. Thus it may be desired to compensate merely for the drop in the converter due to the resistance of the conductor, or it may be desired also to compensate for the loss in the conductors comprising the work-circuit, so that the amount of reverse winding must be made to suit the requirements of different cases.

THE KEYSTONE REVERSIBLE ELECTRIC ELEVATOR MOTOR.

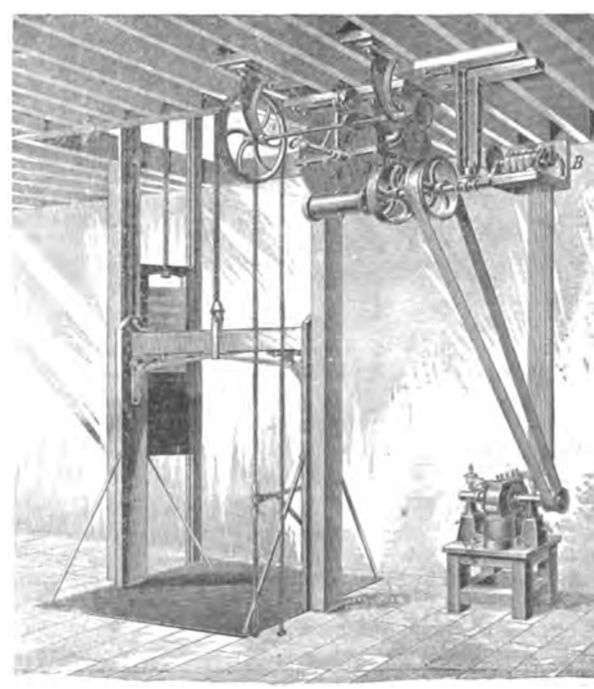
There is perhaps no more severe task to which an electric motor can be put than elevator service. In such situations the full load is constantly being thrown on or off instantly, and the motor is subjected to the most severe strains. To so design a machine, therefore, that will operate without external regulating mechanism of any kind, and which is capable of being started, stopped and reversed instantly, will be conceded to be an achievement of no small merit.

This, however, has been successfully accomplished in the electric elevator equipment now being built by the Keystone Electric Co., of Erie, Pa., and the manner in which it has been carried out is illustrated in the accompanying engraving.

Here, it will be seen, a constant potential motor drives a counter-shaft connected by worm gear to the winding drum A. The motor is controlled entirely by means of the switch B, which is attached by a sprocket-wheel and chain to the brake shaft C, which is controlled by a rope manipulated by the attendant on the elevator.

The motor is so wound that no external resistances whatever are required, the control being effected entirely by means of the switch B. Another important advantage of the arrangement consists in the fact that the motor stops with the elevator, so that when the elevator is not running no current whatever is consumed.

To accomplish the quick starting and stopping of the elevator without detriment to the motor the brake D is employed, which bears upon a brake wheel mounted on the driving shaft. It will also be noted that the brake shaft carries a cam, E, which is so arranged that when the attendant starts the elevator the cam lifts the weight W



The Keystone Electric Elevator.

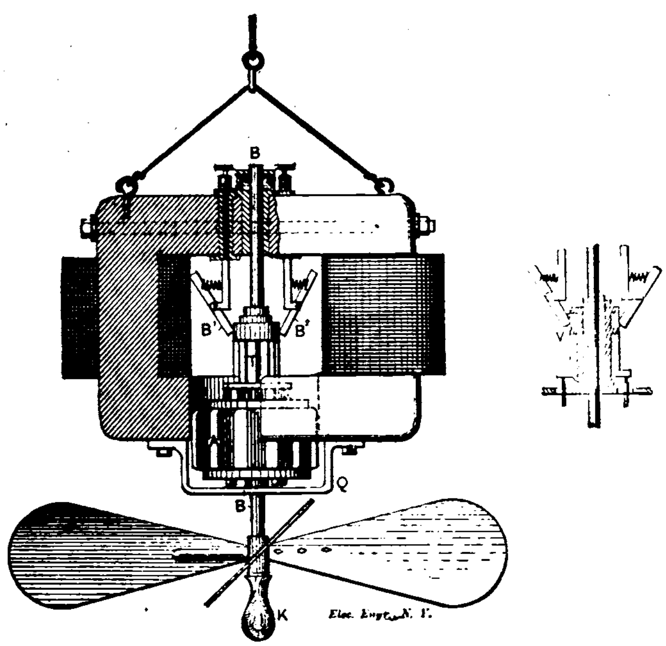
attached to the brake shoe, and allows the motor to start the elevator. When it is desired to stop the elevator, the cam is turned a quarter revolution in the opposite direction, which allows the weight W at the end of the brake arm to fall and apply the brake, bringing the elevator to a short stop. It will thus be seen that while the elevator can be stopped in the shortest possible space, the motor can never be started while the brake is on, since the starting switch is directly connected to the brake shaft. It is, therefore, evident that no matter how carelessly the elevator is handled, the motor cannot be burned out by starting the current while the brake is on, as has frequently been the case where the switch and brake act independently of each other. This excellent elevator arrangement has been designed by Mr. C. J. Sturgeon, electrician of the company, and is already in operation, in sixteen different installations, at Pittsburgh and Erie, Pa.

A NEW TYPE OF FAN MOTOR.

BY

C. J. Kintner

THE enormous demand for electric fan motors within the past two or three years has caused inventors to exercise no small amount of ingenuity in the adaptation of electric motors to this use; but although there are many types in existence, the writer believes that the motor designed by him and illustrated in the accompanying engraving embodies a number of advantages not obtainable in the ordinary type of fan motor.



FIGS. 1 AND 2.—KINTNER'S VERTICALLY-SUSPENDED FAN MOTOR.

It is a well-known fact that in a small motor the friction of the bearings absorbs an appreciable proportion of the electrical energy which should be utilized in driving the fan itself. It was with a view, primarily, of reducing the friction to a minimum that this motor was devised. The motor, which is illustrated in Fig. 1, is of the two-pole type, the field magnets being joined at their neutral point by a pair of bolts. An oblong journal box of non-magnetic material provided with an oil box at its upper end is secured between the two field magnets, the armature A being carried by a vertically arranged spindle, B, and supported, when out of action, by a non-magnetic yoke, Q, bolted to the lower ends of the field magnet poles.

The free ends of the commutator brushes rest normally on a ring of insulating material just out of contact with the ends of the commutator strips T. The field magnets and the armature are usually connected in series. The fan is secured to the shaft, and a ferrule or handle, K, is provided for lifting the shaft, the fan and the armature bodily until the commutator strips T come into electrical contact with the brushes.

The operation of the apparatus is as follows:

The attendant lifts the fan and armature by the handle K until the brushes B¹ B² make electrical contact with the strips T. As soon as the circuit is established the armature is drawn up and retained in its position by the magnetic influence of the field upon its iron core, and it rotates and is held continuously in this suspended position, the reactive influence of air upon the fan aiding to thus hold it up. When it is desired to stop the motor, the attendant simply grasps the handle and pulls the armature down into the position shown in the engraving, breaking the circuit between the brushes and the commutator strips.

Owing to the lifting effect of the fan and the magnetic action between the field and the armature when running at normal speed, the motor is self-regulating, for the reason that any tendency to run away causes the fan to tend to lift the armature out of the field, while the magnetism in the field tends to hold it back.

Among the advantages which the motor possesses may be mentioned its slight bearing friction, so that it may be provided with ball or gravity journal bearings, and hence requires no oil.

Besides, no additional switches are required, the commutator brushes acting as switches and breaking the circuit at two points at the same time, thereby reducing the spark.

Any number of these motors may be stopped at the same time by breaking the circuit for an instant, thus allowing the armatures to drop by their own weight upon the yokes, after which the circuit may be re-established for any lamps which may be in use upon the same circuit, the circuit through the motors being then permanently broken between the commutator brushes and the insulating ring on which they rest. This arrangement, therefore, affords a simple and efficient means for cutting out a motor from the central station after the user has left his place of business, if he has failed to disconnect it before leaving. In the engraving, Fig. 2, there is shown a modified arrangement for use in connection with series lamps or motors, the brushes in this instance resting upon the conducting ring V when the armature is in its lower position, so that the current travels from one brush through the ring to the other brush and on to the next lamp or motor.

ATMOSPHERIC ELECTRICITY.

METEOROLOGICAL observatories are generally ill adapted, by reason of dust and smoke, for observations on atmospheric electricity; and, with the view of inciting private individuals to such work, Herren Elster and Geitel, of Wolfenbüttel, have lately issued a *brochure*, in which they indicate the ends to be sought and the instrumental means. Three things demand attention: First, systematic observation and measurement of electricity in the open air at different times in the day, humidity and air temperature being determined at the same time; second, measurement of the fall of potential with a clear sky; and third, measurement of the fall of potential and its change of sign during rain, etc. The instruments and methods recommended are such as present little difficulty for private persons.

ELECTRIC TRACTION AT BREMEN.

THE Bremen Strassenbahn Gesellschaft has contracted with the Thomson-Houston International Electric Company for the electrical equipment of two-thirds of its Bremen system. The line that was in operation last summer at the Exhibition is to be retained, and a further line of four miles is to be equipped with six motor cars and as many tow-cars as may be required. The Bremen Company proposes to work its system by electricity as soon as the first portion is ready. The Bremen Strassenbahn Gesellschaft is the first tramway company in Europe to purchase outright an electric tramway. It will be remembered that an electric line was run very successfully by the Bremen Tramway in connection with the Thomson-Houston International Electric Company last summer. From June 22d to October 15th, 1890, 586,518 passengers were carried.

THE HAVANA, CUBA, ELECTRIC LIGHT STATION.

THE city of Havana is moving with the times, and one of the latest of the many improvements that have taken

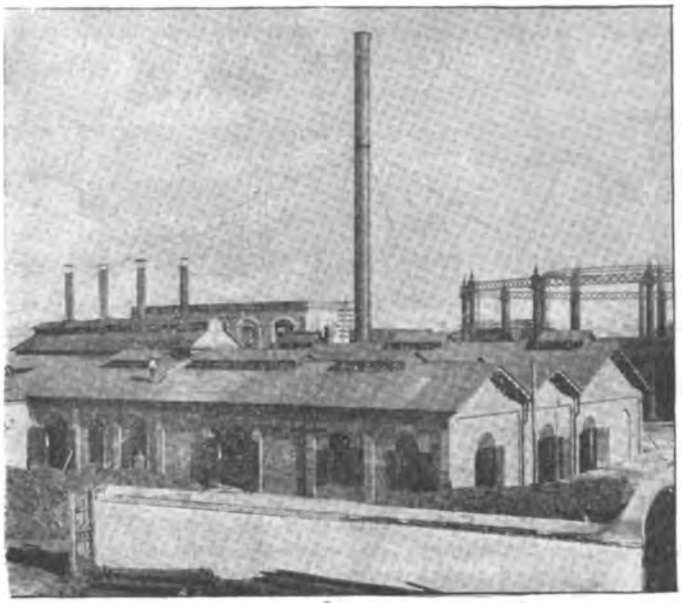


FIG. 1.—GENERAL VIEW OF THE HAVANA, CUBA, ELECTRIC LIGHT STATION.

place has been the establishment of a central lighting station.

The plant was erected by the Spanish-American Light

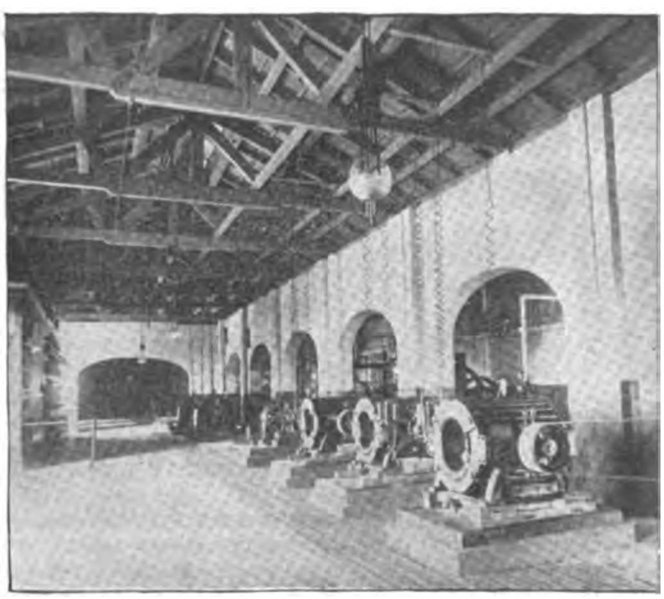


FIG. 2.—ARC LIGHT DEPARTMENT, HAVANA ELECTRIC LIGHT STATION.

& Power Company, who also own and control the gas works, and is situated on the same property, at a distance of about 1½ miles from the business portion of the city.

Three years ago a small plant was erected consisting of a 1,500 light Westinghouse A. C. dynamo, and 150 light Thomson-Houston arc machine with the necessary power for driving the same. The demand, however, for electric lighting soon exceeded the capacity of the dynamos installed, and it was determined by the directors of the company, after obtaining the necessary franchises and the assurance from the municipal government that it would pay for public lighting by electricity in place of gas, that the station be enlarged, capable of lighting 8,250 incandescent lamps and 500 arc lamps.

This plant, which was erected under the supervision of

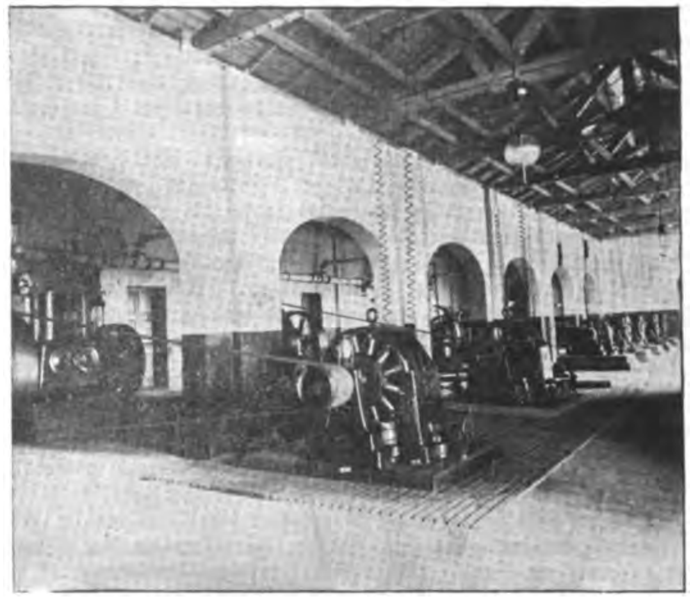


FIG. 3.—INCANDESCENT LIGHT DEPARTMENT, HAVANA ELECTRIC LIGHT STATION.

Mr. W. H. Fleming, is situated in a building, of which a view is shown in Fig. 1. It is of brick, 195 feet long by 90 feet wide, one story, covered with an iron roof. The building is divided into three parts running the entire length, with a width of 30 feet each.

The engine and dynamo rooms are joined by large

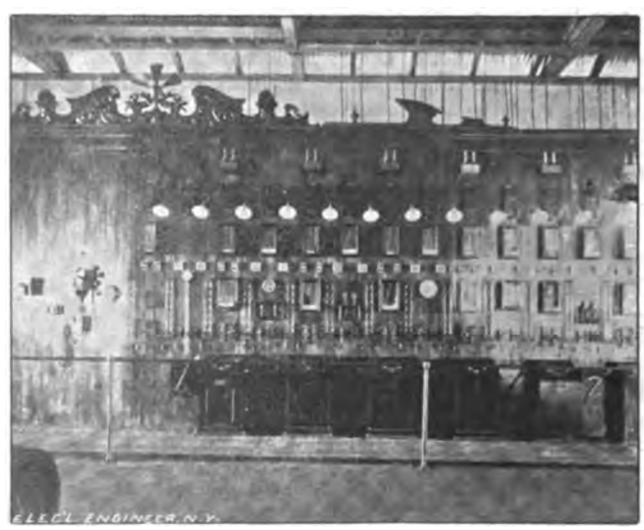


FIG. 4.—SWITCHBOARD, HAVANA ELECTRIC LIGHT STATION.

arches, so that at all times both engines and dynamos are in full view of the person in charge.

The boiler room is fitted with four Hazelton "Porcupine" boilers, of 150 h. p. each, and three 150 h. p. by Bartlett, Hayward & Co., of Baltimore, making a total of

1,050 h. p. The engine room has the following engines, all in line: four 150 h. p. Armington & Sims; one 150 h. p. Westinghouse; three 100 h. p. Armington & Sims; three 75 h. p. Armington & Sims; one 75 h. p. Westinghouse Company. Both the Westinghouse engines exhaust into separate Worthington independent condensers. The Armington & Sims engines exhaust into the feed-water heaters and then into an underground canal to a brick chimney 150 feet away from the station. In this way all the dirt and noise of exhaust is avoided and no trouble with backing up of condensed water in the exhaust is encountered.

In the dynamo room, Figs. 2 and 3, the dynamos are placed in one long room and are as follows: five 1,500 light A. C. Westinghouse, each self-excited; one 750 light 2,000 volt A. C. Westinghouse; ten 50-arc light 1,200 c. p. Thomson-Houston dynamos.

The incandescent switch board, shown in Fig. 4, is made of red cedar, 48 feet long, 15 feet high, with a raised platform in front carefully insulated from the ground. The board is supplied with all the most modern appliances. Each circuit has its own "Booster," ammeter, voltmeter, lightning arrester and compensator. Each circuit is brought to a central changing switch where it is connected to the ground detector. The arrangement of the changing devices is very convenient, the attendant being able to change from one dynamo to the other without moving from his position. The arc switch-board is very handily arranged for twelve circuits. The entire station is floored with Portland cement blocked off so as to represent paving. The pumps are supplied with fire outlets and hose.

The arc lighting is chiefly employed for illuminating the principal streets and public parks; the incandescent lighting for stores, dwelling houses and tobacco factores. By a recent order of the Government all theatres and places of amusement are to be lighted with incandescent lamps, otherwise their license is to be cancelled—a wise provision, and one which has a still greater tendency to increase the popularity of electric lighting.

It can be safely stated that there are few stations in this country that can compare with the Havana plant in the general completeness of the mechanical and electrical appliances that have been installed; it must be mentioned, however, that all the material, including poles of the line work, has been exported from this country.

The officers of the company are as follows: T. J. Hayward, president; R. A. C. Smith, vice-president and treasurer, in New York City; Ricardo Narganes, general manager; F. H. Thompson, electrical superintendent, in Havana.

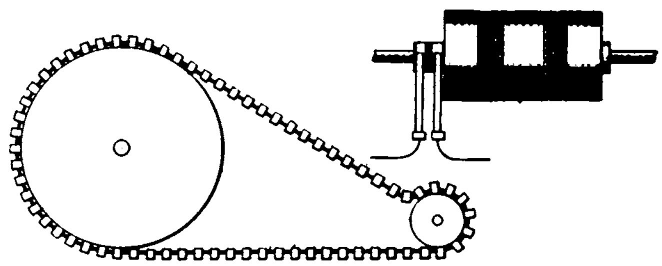
We are indebted to the *American Exporter*, of this city, for the the first three illustrations of this station.

EDISON'S MAGNETIC DRIVING BELT.

The method of increasing the adhesion of belts to pulleys by the aid of magnetic action so as to increase their driving power, though suggested some time ago, has not yet been carried out in practice on account of some of the mechnical difficulties involved. Recently, however, Mr. Edison has taken up the subject and has devised a method by which the efficiency, as well as the wearing qualities of such belts, is greatly increased

The belt which is shown in the engraving, Figs. 1 and 2, is composed of a number of steel wire ropes, upon which are strung cross-bars of soft iron. The wire ropes pass through holes in the bars, which holes, as shown in Fig. 3, are tapered from the centre of the bar outwardly in both directions, and the bar is secured to the wire rope by "setting" the centre of the bar upon the rope. This is accomplished by providing each bar over the horizontal hole through which each rope passes with one or more vertical holes or depressions extending from the top surface of the bar down to near the horizontal hole; by inserting a punch in the hole and driving it downwards the metal of the bar is "set" upon the rope, which is pinched and held so that the bar is fixed in its position with relation to the rope. The bar being set upon the rope at its centre and the hole flaring outwards from that point in both directions, the flexibility of the belt is thus assured.

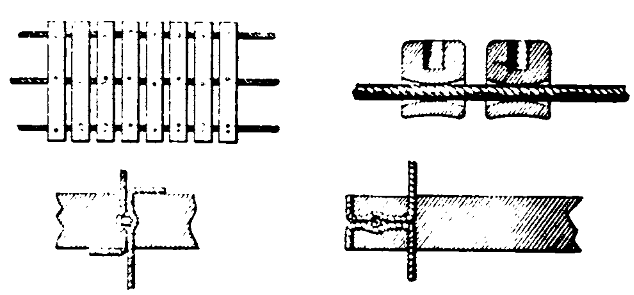
The ends of the wire ropes are secured, as illustrated in Fig. 4, by passing the meeting ends into a horizontal hole, which is large enough to receive them side by side, and is somewhat wider at the centre of the hole than at the ends. A screw-bolt or rivet is forced down between the adjoining ends of the rope, pressing them outwards into the enlarged centre of the hole and securely holding the rope ends; or



FIGS. 1 AND 6.—EDISON'S MAGNETIC BELTING.

if the rope is the one at either end of the bar, as shown in Fig. 5, the ends enter the bar from opposite sides and are then bent at right angles and pass out through a wider hole leading out through the end of the bar, and provided with an enlarged centre, a screw-bolt or rivet being used, as before, to spread the ends of the rope out into the enlarged centre of the hole.

The pulleys over which the endless belt runs are of iron, and are made strongly magnetic by means of magnet windings, which are placed in one or more circumferential grooves, as illustrated in Fig. 6, and are connected with insulated rings, upon which circuit springs rest, the springs connecting the magnetic windings with the source of electrical energy. Both pulleys are made strongly magnetic, and the iron bars of the belt bridge the magnetic windings and close the magnetic circuits about the windings, the bars being attracted to the face of the pulleys and adhering strongly thereto.



FIGS. 2, 3, 4 AND 5.—EDISON'S MAGNETIC BELTING.

In order to make the surface of contact with the smaller pulley as great as possible, the magnetic bars are curved on their inner surface to conform to the circumference of the smaller pulley.

Mr. Edison prefers to more strongly magnetize the small pulley than the larger one. The result of this is to make the belt "strip" more readily from the larger pulley than from the smaller pulley, to which latter the bars will cling, carrying the belt around over a greater surface of the pulley, as shown in Fig. 1, the belt being stripped tangentially from the larger pulley and radially from the smaller one.

ELECTRIC LIGHTING IN THE WESTINGHOUSE AIR BRAKE SHOPS, AT WILMERDING, PA.

BY

G. T. Evans.

IT is probable that no manufacturing establishment is better equipped with electric light than the shops of the Westinghouse Air Brake Co. at Wilmerding, Pa., about 14 miles east of Pittsburgh. The plant consists of carpenter shop, machine shop, iron foundry, brass foundry, blacksmith shop, boiler-house, and superintendent's office. The work of illuminating these buildings was begun about a year ago, by the North American Construction Co., Mr. John W. Rigby, well known in electrical circles for his thoroughness and ability, having direct supervision of all details. Arc lights of the Westinghouse alternating system are scattered about for general lighting, while 100 volt incandescent lamps are placed where precise and delicate work is to be done. The machine shop alone has upwards of 1,300 of these lights, each of the 1,000 lathes and other iron working machines having one or more. To the arrangement of the lights in the machine shop special attention should be drawn. It is most emphatically substantial. Simplex and Okonite wire, supported by porcelain insulators, is run on the ceilings below the machines. The lamp wires are carried from porcelain single-light cut-outs through the ten-inch thick floor in hard rubber tubes, and into substantial iron tubular stands, which are securely fastened to the floor. From these stands the wire is continued through universal jointed brackets to the lamps. This gives an excellent combination of solidity and flexibility. The stands will bear almost any shock, while the lamp may be adjusted to all the positions desired by the workman. At present the electric plant is in the boiler-house, but indications point to a separate power-house in the future. The equipment consists of one self-exciting 60-light arc machine of the Westinghouse alternating system, and two self-exciting incandescent alternaters of 1,500 and 500 lights capacity, also of the Westinghouse system. These are separately driven by Westinghouse compound engines, which are furnished with steam from Babcock & Wilcox boilers, natural gas being used as a fuel. These boilers give steam to a dozen Westinghouse engines throughout the works, the steam being carried underground through tunnels.

It would not be surprising if this plan of conveying power were to give way to an electrical method in time, for it is certainly less economical to carry power by steam for long distances than it is by electric currents.

The switchboard holds the usual Westinghouse apparatus used in controlling that system. The arc circuit is so laid out that the separate shops or the town streets may be lighted as required. The town of Wilmerding is lighted by several pole arc lights, but principally by four lights, set high in the park on Fort Wayne towers.

Wilmerding, outside of the shops, has already been wired for some 3,000 incandescent lights, several hundred of these being in the Westinghouse Club-house, a large building put up by the Air Brake Co. It contains the main offices, and also large rooms for library, billiard-room and natatorium, bowling alley, etc., etc., to be used by the employees. The lights are furnished per meter, the price being very low, viz., one-half cent per hour per 16 c. p. lamp.

The electrical departments of Wilmerding and the Air Brake Works are operated by the Turtle Creek Valley Electric Light Co., Mr. Rigby being general superintendent.

DEFENDING IQUIQUE, CHILI, WITH A 1,200 C. P. LIGHT.

THE political struggle now waging in Chili has had many interesting episodes and has furnished some noteworthy lessons with regard to the use of the tools of modern warfare. We have already heard of the activity of the torpedo launches, and now comes a very amusing story as to the effectiveness of the electric light. Mr. J. Acton Lomax, an electrical engineer, who has been associated with Mr. W. Hoffmann, the Thomson-Houston agent in Chili, has recently arrived in New York from the seat of hostilities. Being stationed at Iquique, the great nitrate port now in the possession of the Congressional party opposed to President Balmaceda, he was called upon by the former to furnish a light for an island about 1,000 yards from the shore in Iquique harbor, the idea being to place this light in a lighthouse standing there. The first plan of Messrs. Hoffmann and Lomax was to put eight arcs, of 1,200 c. p. each, inside a parabolic reflector, which they had made, six feet in diameter and eight feet in length. But although great efforts were made, the plant could not be got to work satisfactorily. They then borrowed from the engineer of the "Cochrane," one of the insurgent, ironclads, one of the old mirrors from her search light. This they rigged up with one of the 1,200 c. p. lights, put the combination in a box and tried it near the dynamo house, getting steam for the engine from the fire-brigade engine house, where steam was always kept up. It threw a ray beautifully. Then they improved it a little by putting a screw in the bottom, so as to raise it as the carbons burned down.

Now came the question of a circuit to the island. It was easy to get the lamp rigged up in the lighthouse, but it was not so easy to supply current to it. They had about 1,200 feet of copper wire in sizes from No. 0 to No. 10, but there was not enough of No. 0 to make an ordinary stretch. After rowing about all over the bay, Mr. Lomax found an old silted-up cylinder in a wrecked steamer. He knocked off the head and put in a big pole, which was steadied with rock, etc. This being about midway, gave him about 500 yards stretch on each side of the pole. Then he had an 80-foot pole both on the land end and the island end. But his wire was not equal to the task, and so Mr. Lomax went to the local telephone company and got from them a lot of No. 6 iron wire, which he used in the circuit. By the time it was finished the circuit was about 3,000 yards. Finally the whole thing was fixed up, but at that juncture the insurgent government did not want to pay, whereupon the plant was shut down. Then one night the saucy "Condell," one of the Presidential torpedo boats, ran into the bay, darted all round the shipping, sent off a torpedo at one of the Congressional ironclads, and "played the devil" generally. The Congressional party, in a great scare, paid for the plant, and it was set going, with the result of lighting up a couple of miles in any direction. It was arranged that any of the Congressional launches, cruising about all the time, should show certain lights, and they did so whenever the beam of light caught them. At last the search light picked up two craft coming in together, showing no light whatever. These suspicious craft made no responsive signal, so the ray was kept steadily on them. Very soon they got tired of this exposure, turned around and made for the open sea. They were evidently torpedo launches sent in by the "Condell" to smash up one or more of the ironclads. After this object lesson of its utility the light was kept going nightly, one of the sailors being instructed in its manipulation. The enemy probably took it at first for a man-of-war with search light, but whatever their opinion on the subject might be, they gave it a wide berth. The light was running when Mr. Lomax left Iquique for this country.

THE INCANDESCENT LAMP INDUSTRY.[1]

BY FRANK GÉRALDY.

THE Chamber of Deputies, during the sitting of July 6th, voted a duty of 500 francs per 100 kilogrammes on all incandescent lamps entering France.

The incandescent lamp market has altered enormously during the last four years. Lamps were then commonly quoted at 5 francs, 4 francs and 4 francs 50 centimes being considered as reduced prices. It was felt that a reduction was sure to come, but it was not foreseen that it would come so quickly, and that it would be so large. To-day incandescent lamps can be had for 2 francs 50 centimes, or 2 francs, and even less.

It is impossible to return to former prices; they are low and will remain so. The protection granted amounts to about .175fr. per lamp, and will not, I think, be sufficient to exclude foreign lamps. If it does succeed in doing so, French lamps will multiply, and home competition will bring down prices to the same level, because, after all is said and done, it is a possible price, and one which a large, well-organized industry should be contented with. The key to success will be the quality of the product. By quality I mean the general properties of a lamp, regular voltage, whiteness of light, long life, ease of fixing, strong construction, and other like essentials. Other more special qualities, such as satisfy the taste and requirements of the consumers, have to be aimed at. The public, indeed, has begun to have some taste in electric lighting matters. Only a little time ago it accepted all that was given it; great choice was not, indeed, then possible; to-day the public has seen, compared, and has its preferences. Certain styles of lamp, certain arrangements of filament, are in request. In Paris, at the present moment, fashion seems to favor looped filaments, and the look of the simple horseshoe shape is considered bare. Lamps, the filaments of which are closely coiled, emitting light from a more restricted centre, and appearing more brilliant, are preferred, and, generally speaking, small sized lamps are wanted.

Taste is also changing with regard to candle-power. Ten candle-power lamps were at first almost the only type asked for, because one such lamp naturally replaced a gas burner. Now people are beginning to take lamps of 16 c. p., and more, which is a good thing, because these lamps are in reality better and more efficient than the smaller units. The art of manufacture should be sufficiently flexible to be able to lend itself not only to meeting the present demands of the public, but probable developments.

1. Abstract from *La Lumière Électrique*.

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Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XII. NEW YORK, AUGUST 19, 1891. No. 172.

I do not think that the way to stop abuses of rights is to destroy the rights themselves.—J. J. Storrow.

THE OLD TIMERS AT WASHINGTON.

ELECTRICAL history is made at a rapid pace in these days, and the youngest of us in the profession or trade soon find ourselves looking back to the time when some new branch of electrical work was being established by our pioneer toil and perseverance. Only this year the first decade of commercial electric lighting was celebrated at Providence, and soon the electric railroad industry will signalise its great anniversaries in like manner. Yet the gathering this week in Washington reminds us that the jubilee of the telegraph will not arrive until after the Columbian Fair has come and gone, and that of the men who were Stanton's "right arm" during the Civil War twenty-five years ago, many are among the leaders in electrical development at this hour, strong, energetic and successful.

It has seemed to us appropriate to take special cognizance of this meeting in Washington of the Old Timers and the U. S. Military Telegraph Corps, and we are glad therefore to be able to present in this issue a few reminiscences, connected with events that have given Washington such prominence in electrical history. One of our articles recites briefly the circumstances that attended the sending of the first message by the Morse telegraph, in 1844, over the line from Washington to Baltimore, and gives the portraits of Miss Ellsworth, who sent that message, and of her father, but for whose friendship Morse, in all probability, would have abandoned his invention and ambitions. When Miss Ellsworth announced to Morse the fact that his appropriation bill for $30,000 had gone through Congress, the inventor had just 37½ cents in his pocket and a ticket for New York.

The article by Mr. Madison Buell tells in a most graphic and vivid manner how the telegraph repaid this investment during the crises of the Civil War, by placing at the disposal of Secretary of War Stanton that magnificent body of men, the United States Military Telegraph Corps, who through the long and weary years of struggle did their duty with noble courage, patience and fortitude, and whose work caused Stanton to say in the hour of the fall of Richmond: "Boys, I consider the telegraph my right arm, and if ever I can do any thing for you don't hesitate to ask for it.'" Strange to say, the only thing those faithful "boys" have ever asked for—mere recognition of their work—has been denied them. But no failure of the conscience of Congress can wipe out the memory of such gallant deeds as those of Bunnell and Nichols, as told by Mr. Buell, or of many another young hero, who, less fortunate, perhaps, went down to their graves the victims of sickness, imprisonment or the bullet.

The career of Mr. Buell himself is characteristic, and his work is part of that splendid record in which all of us take pride. As in so many other things, the Civil War constituted a great line of division between what had been and what is, and from that time dates, in effect, all the newer work in this country. The U. S. Military Telegraph Corps drew into its ranks the very flower of the Old Timers, and its members when released from war service threw themselves with unabated energies into quieter occupations. It is significant that immediately after the war we see Mr. Buell, under his old chief, Gen. Eckert, busy reconstructing the Western Union system, and doing his share of the task of carrying out the ideas and suggestions of Cromwell Fleetwood Varley. And what we have written of Mr. Buell, still active in the service to which he has been devoted these forty-five years, might be said of others who came out of that fierce ordeal of the war, to turn its lessons to account in the arts of peace.

ELECTRIC LIGHTING IN HAVANA.

OUR columns have recently contained a number of articles showing the popularity of electric lighting in tropical and sub-tropical regions. One of these articles dealt with Australia; one with the Sandwich Islands, and a third with Jamaica, West Indies. This week we publish a description of the plant at Havana, Cuba. The magnitude and growth of this station has hardly been suspected, but the electric light is pre-eminently *the* light for hot climates, and we need not wonder at its popularity in the largest city of the Caribbean. It is well worthy of note that in all the instances we have mentioned the alternating system enjoys great vogue. This is not to be wondered at. Buildings in hot climates are not high, but cover a great deal of ground with their piazzas and courtyards. Hence, the compactness of the American city, with its 15 story edifices, is missing, and the population spreads out over a great many square miles of territory in a manner that only those familiar with bungalows and patios can realize. Evidently in such cases the alternating system with its long arm reaches for patronage that would otherwise be impossible. The same tendency to expansion in tropical cities has made street railways necessary and successful, and it is more than likely that electricity will be resorted to as superior to the mule or steam dummy. This change of motive power has already begun.

THE INCANDESCENT LAMP INDUSTRY IN FRANCE.

THE voting of a duty of 500 francs per 100 kilogrammes on all incandescent lamps imported into France serves to draw attention to the state of the industry in that country, and brings out strongly the protective lines of policy, adopted by French manufacturers, paralleling those in this country. There also the price of lamps four or five years ago ranged between 80 cents and $1, while to-day lamps can be had for 40 or 50 cents. It has, however, been deemed necessary to grant French manufacturers protection from foreign competition, but we fail to see how the comparatively small duty of less than four cents per lamp will exclude those of foreign manufacture. Judging from the price at which lamps can be made in this country and the acknowledged cheapness of labor abroad, there is no reason why the present price of lamps manufactured in France should not be still more reduced from the figure given above, and it is to be expected that the levying of this duty will have this very effect, as foreign lamps will be brought in competition with the French in spite of the added duty. It is interesting to note also the expression of preference for certain styles and sizes of lamps, and even in the form of filament. Perhaps the most striking part of this is to be found in the more general adoption of small-sized lamps, which we believe will also find more recognition here than has been accorded them in the past.

THE MONTREAL CONVENTION.

GARDEN parties, conversaziones, promenade concerts, lacrosse matches, drives, banquets, excursions, Lachine Rapids, yacht trips—such are a few of the items in the welcome that awaits the National Electric Light Association at Montreal. Mr. Corriveau has more than fulfilled his promise that Canada would give the association as cordial a reception as it could meet with in any city of the Union, and it becomes the duty of everyone interested in the electric light and power industry to show that the kindness of these Canadian friends is appreciated.

There is every reason to believe that the convention will be signalized by good work as well as by generous entertainment. The programme that we print in another column is excellent, and embraces a brilliant list of names and subjects. The exhibition, too, is beginning to assume large proportions, and it will be without doubt one of the largest and best given under the auspices of the association. As an object lesson in the applications of electricity, the exhibition has great value, and the association has never yet visited a city in which a greater demand for electrical apparatus has not followed the display. It is certain that Montreal will prove no exception.

From what we hear, it seems likely that the attendance will be large, and we would heartily recommend our readers to seize this opportunity of visiting the Dominion. The chance is a rare one, and as the attractions are so many, it may be expected that the ladies will be out in force. Probably Montreal will see the last of the semi-annual meetings, as the sentiment in favor of one meeting a year is now so strong as to be practically irresistible. Under these circumstances, it behooves everybody to turn in and work with the object of making the Montreal convention the most memorable thus far held by the association.

The headquarters of the N. E. L. A. for the convention beginning September 7, will be at the Windsor Hotel. The rates there will be from $3.50 to $5 per day each. At the St. Lawrence Hotel the rates will range from $2.50 to $4. Special rates of railroad fare have been obtained from the various Traffic Associations on the certificate plan. Those attending the Convention will pay full fare going to Montreal and one-third returning, provided they return by the same route.

High-Tension Alternating Currents on Underground Cables.

THE increasing use of underground cable for high-tension work within cities has served to bring out a phenomenon, the importance of which cannot be overlooked, and which requires the attention of electrical engineers in order to leave such a system free from troubles and possible danger to those handling them. In the cables employed by Mr. Ferranti it has already been noticed that the potential at the far end of the line exceeds that at the generator, and the cause has been very satisfactorily traced to the influence of the static capacity of the cable. A communication this week by a correspondent describes another phenomenon analogous to that just referred to, which we hope will lead to a thorough investigation on this subject; and we will gladly open our columns to a discussion of the means for obviating the difficulty pointed out.

A Vertically-Suspended Fan Motor.

THE changes and modifications to which the ordinary type of electric motor has been subjected have probably not been paralleled in any other prime mover. In few of these changes, indeed, is any radical departure discernible, the majority consisting merely in modifications of detail rather than in the application of new principles of construction. This week, however, we describe a type of fan motor designed by Mr. C. J. Kintner, which exhibits several novel features. The operation of the shaft in a vertical position offers several advantages, which are pointed out by Mr. Kintner, the most interesting of which, probably, is its automatic regulating qualities.

Mechanical Storage Battery Filler.

THE introduction of machinery for work formerly done by hand is usually followed by a reduction in the price of the manufactured article, and the application of machinery to the manufacture of storage batteries, replacing the former process of pasting by hand, will probably be followed by a similar reduction. A machine employed for this purpose by the Consolidated Electric Storage Battery Company is described on another page, and, as will be noted, it applies the active material in the shape of dry powder, which is compressed into a solid mass within the grids, the plates being subsequently "formed" in the usual way.

THE ASSOCIATION OF EDISON ILLUMINATING COMPANIES.--SEVENTH ANNUAL CONVENTION, HELD AT NEW YORK.

THE Seventh Annual Convention of the Association of Edison Illuminating Companies met on Aug. 11. at the Murray Hill Hotel, with a very full attendance. The list of those in attendance, given below, comprises representatives from a large number of Edison Illuminating Companies from all over the country, in addition to the representatives sent by the Edison General Electric Co. and Mr. Edison.

The following delegates were present:

EDISON GENERAL ELECTRIC CO., New York:—J. Hobart Herrick, 1st vice-president; Samuel Insull, 2d vice-president: E. H. Johnson, director; J. P. Ord, comptroller; S. Dana Greene, assistant to 2d vice-president; Morris Slattery, agent Southern District; F. R. Upton, general manager, lamp manufacturing department; Sidney B. Paine, district manager, New England District; W. S. Kelley, engineering department; H. T. Edgar, engineering department; W. T. M. Mottram, assistant to district manager, Southern District; S. A. Douglas, New England District; L. Stieringer, guest.

Lamp Manufacturing Department:—Wilson S. Howell, inspector; Francis E. Jackson, inspector.

Light, Power and Intelligence Departments:—H. Ward Leonard, general manager.

Legal Department:—W. J. Jenks; B. W. Hammer; W. H. Lauman.

Eastern District:—Charles D. Shain, district manager.

Southern District:—A. H. Reece, district manager.

Official Stenographer:—M. J. Sullivan.

Edison Laboratory:—A. E. Kennelly.

EDISON ELECTRIC ILLUMINATING CO., of New York City:—R. R. Bowker, 1st vice-president; J. B. Skehan, treasurer: H. J. Smith, general operating superintendent; H. A. Campbell, assistant superintendent; J. Van Vleck; Arthur Williams; Henry Stephenson, superintendent underground construction; W. I. Donishea, assistant electrician; F. M. Tottingham, superintendent 2d district; Frank H. Briggs, acting superintendent 3d district; J. H. Tyler, superintendent meter department; J. E. Sayles, general agent.

GRAND RAPIDS EDISON LIGHT & FUEL GAS CO., Grand Rapids, Mich.:—A. F. Walker, superintendent; T. C. Harnish, constructor.

APPLETON EDISON LIGHT CO., Appleton, Wis.:—A. L. Smith, president.

CONSOLIDATED ELECTRIC LIGHT CO., Birmingham, Ala.:—Leigh Carroll, secretary and general manager.

DES MOINES EDISON LIGHT CO., Des Moines, Ia.:—J. A. Colby, director, secretary and manager.

COLUMBUS EDISON ELECTRIC LIGHT CO., Columbus, O.:—A. W. Field, secretary and manager.

EDISON ELECTRIC LIGHT & POWER CO., St. Paul, Minn.:—Geo. H. Finn, secretary and treasurer.

EDISON ELECTRIC ILLUMINATING CO., Lawrence, Mass.:—W. H. Wolvekamp, electrician.

EDISON ELECTRIC ILLUMINATING CO., Topeka, Kan.:—W. W. King, superintendent.

EDISON ELECTRIC ILLUMINATING CO., Westchester, Pa.:—Maurice Hooper, superintendent.

EDISON ELECTRIC LIGHT & POWER CO., Kansas City, Mo.:—W. Preston Hix, director.

EDISON ELECTRIC ILLUMINATING CO., Amsterdam, N. Y.:—J. H. McClement, vice-president; H. K. McCoy, general manager; T. D. Mosscrop, secretary and treasurer.

WINSTON-SALEM RAILWAY & ELECTRIC CO., Salem, N. C.:—J. H. McClement, president; H. S. Cooper, general manager.

EDISON ELECTRIC ILLUMINATING CO., Hazleton, Pa.:—J. Edwin Giles, manager.

EDISON ELECTRIC ILLUMINATING CO., New Orleans, La.:—Wm. Oswald, director.

EDISON ELECTRIC ILLUMINATING CO., Philadelphia:—Wm. D. Marks, supervising engineer and general manager.

EDISON ELECTRIC ILLUMINATING CO., Paterson, N. J.:—Wm. M. Brock, manager and secretary.

EDISON ELECTRIC ILLUMINATING CO., Pottsville, Pa.:—Geo. H. Barker, manager.

READING ELECTRIC LIGHT & POWER CO., Reading, Pa.:—T. P. Merritt, J. K. Righter, general manager.

EDISON ELECTRIC ILLUMINATING CO., of Brooklyn, N. Y.:—C. E. Chinnock, director; W. D. Barstow, general superintendent; R. Lindsay.

EDISON ELECTRIC ILLUMINATING CO., of Boston, Mass.:—Walter C. Baylies, vice-president; C. L. Edgar, general manager; W. A. Hill, cashier; Chas. E. Pattison.

HARRISBURG ELECTRIC LIGHT CO., Harrisburg, Pa.:—John I. Beggs, director; W. R. Fitzpatrick, superintendent and electrician.

EDISON ELECTRIC ILLUMINATING CO., of Detroit, Mich.:—C. P. Gilbert, secretary and manager; Hoyt Post, attorney; Barton L. Peck, motor inspector.

TIFFIN EDISON ELECTRIC ILLUMINATING CO., Tiffin, Ohio.:—A. Kaup, manager.

EDISON ELECTRIC LIGHT & POWER CO., Little Rock, Ark.:—G. H. Van Etten, president.

ELGIN CITY RAILWAY CO., Elgin, Ill.:—Chr. Wustenfeld, manager.

SCRANTON ILLUMINATING, HEAT & POWER CO., Scranton, Pa.: J. E. Parrish, superintendent.

WILMINGTON CITY ELECTRIC CO., Wilmington, Del.:—C. Reginald Van Trump, general superintendent and manager.

TORONTO INCANDESCENT ELECTRIC LIGHT CO., Toronto, Can.:—Frederic Nicholls, manager and secretary; J. K. Herr, director and attorney.

RENOVO ELECTRIC LIGHT, HEAT & POWER CO., Renovo, Pa.:—J. H. Sheddy, general manager.

FOREST CITY ELECTRIC LIGHT & POWER CO., Rockford, Ill.:—M. A. Beal, secretary, treasurer and manager.

MT. HOLLY ELECTRIC LIGHT & POWER CO., Mt. Holly, N. J.:—J. L. Jamison, superintendent and treasurer.

EDISON ELECTRIC ILLUMINATING CO., Rochester, N. Y.:—H. L. Brewster, secretary.

The morning session was occupied with the reception of credentials of delegates, an address by the President of the Association, and the reading by Mr. A. E. Kennelly, of Mr. Edison's laboratory, of reports of committees on "Grounding Neutral Wire on Three-Wire Systems," and "Lightning Protection;" and a report by Mr. C. P. Gilbert, of Detroit, Mich., chairman, read by Mr. H. Ward Leonard, manager of the Light and Power Department of the Edison General Electric Co., on "Dangers to Edison Circuits from Crosses with High Potential Conductors." The reports were followed by a free discussion on these topics.

The convention extended the privileges of a portion of its session to Mr. A. S. Hibbard, general superintendent of the American Telephone and Telegraph Co., and Mr. John J. Carty, electrician of the Metropolitan Telephone and Telegraph Co., during the discussion of the reports on Protection from Lightning and High Potential Circuits.

On reconvening, at 2:30 p. m., the delegates were invited by the officials of the Edison Illuminating Co., of New York, to visit in carriages their various operating stations and the new Elm street station, now in process of construction: also to accept the further hospitality of the company in a dinner at the Brighton Beach Hotel, returning in the evening.

SECOND DAY'S SESSIONS, AUG. 12.

The morning was taken up in the discussion of Mr. A. E. Kennelly's report on the "Grounding of the Neutral Wire in Three-Wire Systems," read the day before; the reading of a paper by Prof. Wm. D. Marks, supervising engineer and general manager of the Edison Electric Light Co., of Philadelphia, on "How to Get Paying Loads for Stations;" the reading of a paper by Mr. R. S. White on "The Edison Meter in the Brooklyn Station;" an address by Mr. Samuel Insull, second vice-president of the Edison General Electric Co., on the present business policy of the parent company, the outlook in the patent suits, the condition of the business, etc.

On Thursday the delegates were given an excursion to Schenectady by the Edison General Electric Co., a special train of Wagner parlor and dining cars being provided for the purpose. The party, numbering about 150, started at 6 A. M., and breakfast was served at 6.30. By ten o'clock the great works at Schenectady, described in THE ELECTRICAL ENGINEER last week, were reached, and the train was run into the work-yard. The party was greeted by Messrs. Kruesi and Gilmore, the managers, who, with Messrs. Herrick, Insull and Dana Greene, then escorted the party through the fifty and odd buildings that constitute the establishment. The perambulation, even at a four-mile gate, occupied over two hours, and some 3,000 people were seen employed in every variety of handicraft connected with the construction of electric power and lighting apparatus. Then lunch was served on the train, and the heat of the August midday was delightfully banished by a number of Edison fan motors placed in the cars, current for them being supplied over a special cable from the works power-house. After lunch the visitors were permitted to examine more closely and in detail any part of the work that had interested them during the morning; and as the train had left New York so early, the fact that one of the works offices had been converted into a full-fledged barber's saloon was hailed by not a few with the liveliest manifestations of delight and gratitude at such thoughtfulness.

In short, nothing that could contribute to the comfort of the large party was omitted. At about 2.30 the train was run out again on to the main railroad, and by 5 o'clock an admirable dinner was served, with the beautiful Hudson River scenery as a setting. New York was reached at 7.05, and it is safe to say that 300 miles of travel and 12 hours of continuous sightseeing were never spent with more genuine pleasure and satisfaction.

On Thursday evening the delegates, refreshed rather than tired, by their day's outing, were again the guests of the local Edison Illuminating Co., and in that capacity enjoyed the concert at Madison Square Garden, inspecting the plant, the stage lighting effects and the tower. Then "home well pleased they went."

THE STORAGE BATTERIES OF THE CONSOLIDATED ELECTRIC STORAGE CO.

THE decision of Judge Coxe, awarding to Mr. Brush the sole right to the mechanical application of active material to a storage battery plate, has served again to call attention, prominently, to this department of work, and has served to place on a more stable foundation an industry which has for a long time suffered from the retarding influence which surrounded it on account of the legal questions involved.

The Consolidated Electric Storage Company, as the manufacturers of the Julien storage battery, and the sole licensees under the Brush patent, have for some time past devoted special attention to the improvement of their batteries, and also to methods for cheapening their cost. Both these objects have been accomplished by the employment of a mechanical filler, by the use of which the active material is mechanically applied to the plate and which does away with the tedious pasting process.

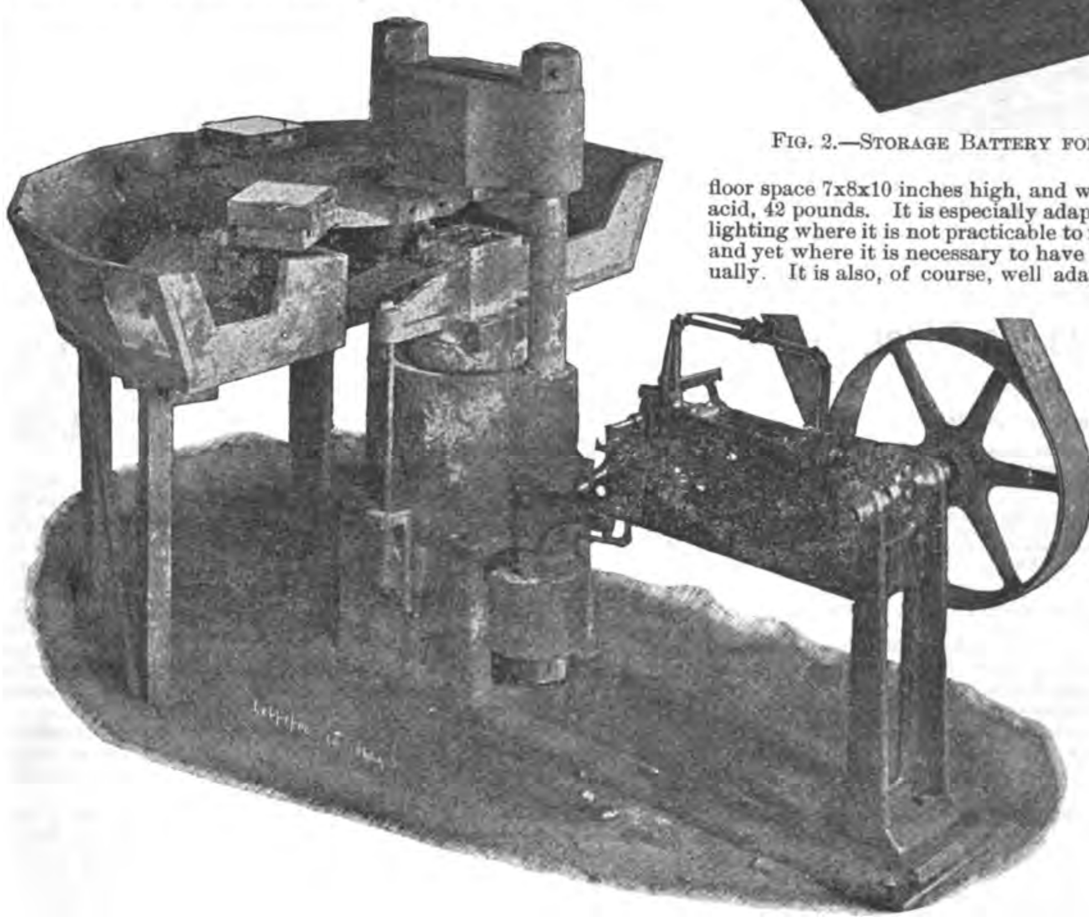


FIG. 1.—MECHANICAL FILLER FOR STORAGE BATTERY PLATES.

The apparatus by which this is accomplished is shown in the accompanying illustration, Fig. 1. As will be seen, it consists of a hydraulic press, obtaining its pressure from a pump driven by a belt and pulley. The plate to be filled with active material is placed in a die, which forms the top of the piston plunger of the hydraulic press. The active material, placed above and below the plate in the form of dry powder, is then brought up by the press against the opposite head, and the active material is then forced into the grid, so as to form a solid and compact mass. This operation requires less time than it does to describe it. Thus, one of these machines with two boys will fill 2,000 plates per day, and hence replaces the work of 80 skilled men, which would be required under the old method of pasting in the active material by hand.

The standard type of electric lighting and power cell, known as the S 17 accumulator, is shown in the accompanying illustration, Fig. 3. It has 180 ampere hours capacity, and its maximum charging rate is 15 amperes, and discharging 20 amperes. It occupies a

FIG. 2.—STORAGE BATTERY FOR MEDICAL PURPOSES.

floor space 7x8x10 inches high, and weighs, complete, set up with acid, 42 pounds. It is especially adapted for isolated incandescent lighting where it is not practicable to run an engine night and day, and yet where it is necessary to have lamps day and night continually. It is also, of course, well adapted to the running of arc lights on low potential circuits, and stationary motors in isolated installations.

The company have also devoted a large amount of their attention to special types of storage battery, among which their medical type deserves attention. This type, Fig. 2, has been designed for the medical and dental professions, and is specially adapted for conducting long and difficult operations where a constant current of considerable strength is required for a comparatively long period of time. It consists of four accumulators, each of which has a capacity of 50 ampere hours, each being capable of discharging at the rate of seven amperes. The plates are enclosed in rubber jars with sealed covers, and encased in a polished hard-wood box, which also contains resistance coils and a commutator, by which the operator is able to vary the voltage from 2 to 8 volts, and the current from 1 to 30 amperes. It can, therefore, be used equally well for small incandescent lights from 1 to 8 c. p., for galvano cautery, and for running small motors, circular saws, etc.

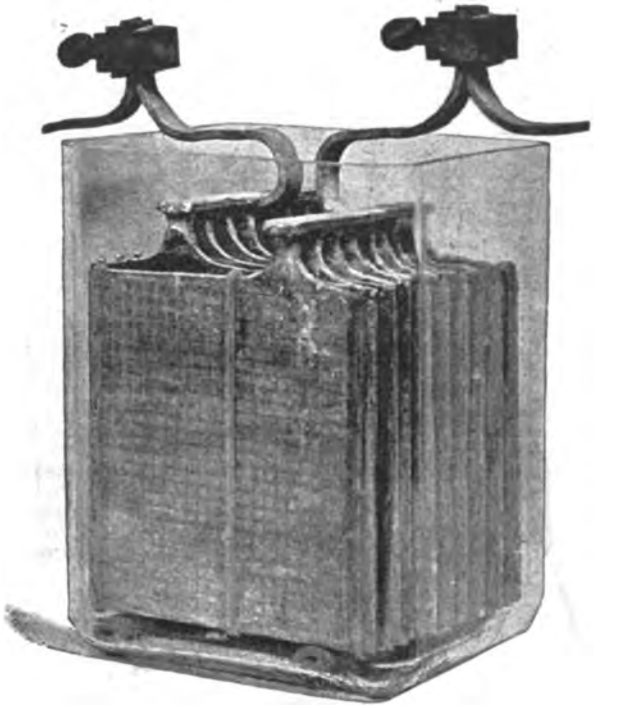


FIG. 3.—ELECTRIC LIGHT AND POWER STORAGE BATTERY.

Among the other special types of cell built by the company is the traction type, which weighs about 20 pounds with a rubber, and occupies a space 7½x5¾x9 inches high.

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

ELECTRICITY AND MINE VENTILATION.

THE above is the heading of a cutting from the *Coal Trade Journal* which appeared in your July 15 issue. I am not astonished at your publishing it, but it *did* surprise me to see the *Engineering News* endorse the views therein set forth. Now, to save any electrical man from putting up this idea when talking to mining men, I would like to state that there is nothing in it, from begining to end; it is simply "no good;" and for the following reasons:

Mr. Quackenboss "has made an investigation," advances a "novel theory that the prime cause of explosions in mines is due to the combination of *blower fans* and falling barometer." He then cites the explosion at Wilkesbarre to bear this out; but it does not bear out his theory, because, if he had investigated, he would have found that this mine is not ventilated with a *blower fan*, but with an exhaust fan. The July issue of the *Colliery Engineer* says on this subject: "There are no blower fans used in the region mentioned, all the collieries being ventilated by exhaust fans." It has been the practice for the past 30 years to use exhaust fans wherever it is possible, and this is so in the majority of cases.

Next comes the falling barometer. It has been thought that barometric changes did influence the quantity of gas given off in coal mines, and the English Government has been issuing warnings for the past 20 years of the possible approach of such changes; so there is nothing new in this discovery of Mr. Quackenboss'.

From a chemical point of view the theory may be all right, but the practice of mine ventilation for the past 30 years certainly does not uphold this theory. The only way to get rid of gas in the mines is to have considerably more than sufficient air and to use it. More than this, it is not the volume of gas given off on a fall of barometer that is the most dangerous, but the quantity of gas forced out into the gangways by larger or smaller falls of roof, and for this reason the falling pressure allows the gas to come out easily and slowly, and there is time to detect it. Probably the air current will blow it all away, but the sudden rush from the fall of the roof is dangerous because there is no warning, no time given at all; the danger is there all at once; it is like an earthquake, but worse, for it is in the dark; no sound, no smell, no trembling of the earth, until the one awful sheet of flame passes, tearing the timber out of its place and burning everything in its course.

Not once, or twice, is the battle fought underground; it is, in many mines, an incessant warfare between man, with fresh air for a gun, and the demon of the mine—gas—and when there is enough of it, the fresh air can win every time.

As to the electric motor underground, there are very few places where the mining engineer will ask for it that it will not be safe for it to be put. For coal cutting it can undoubtedly be made safer than the safest safety lamp; the machine may work as long as as the lamps can stay there and work the cutter, and that is one of the greatest uses for the electric motor underground; for pumping, where the motor is stationary, the machine can be made perfectly safe for a far longer time than the safety lamp. And for many other purposes the machine can be made perfectly safe. The greatest difficulty is not in the motor, but in the switch and rheostat, and there is no reason why these should not be as thoroughly protected.

Mining engineers are, as a rule, trained to overcome difficulties, and not to make them, and the mining engineers of this country are only just beginning to look to the electric motor as a means to do much work that has been most costly before; electricity is on trial and its work in the mine hardly begun. When the mining engineers see that it has come to stay, that it can do good work, that it is a machine and not a toy, then the development of electrical mining machinery will vastly exceed even the tremendous street railroad work which has been most astonishing, and the question will not be, Shall we use electricity or compressed air, but, Shall we use electricity or close the mine?

FRANCIS A. POCOCK,
Certified Mining Engineer.

SCRANTON, PA.

INFLUENCE OF ELECTROSTATIC CAPACITY ON ELECTRIC LIGHT CABLES.

IF it is not permissible, from considerations of safety to life, to operate high-tension continuous currents on grounded circuits, with, or without, static capacity, is it safe, for similar reasons, to operate high-tension alternating currents on circuits of large electrostatic capacity, even though their insulation be very perfect?

I recently laid two submarine cables, ⅛ mile in length, whose insulation resistance was 2,000 megohms, but whose static capacity was very large, due to the high specific inductive capacity of the compound used as insulation. The cables were connected to an alternating current dynamo giving a pressure of 1,100 volts and a frequency of 125 per second, supplying current for the lighting of a small village, which could only be conveniently reached by cable. In order to test the effect of the cable's capacity, I connected one end of the primary of a transformer to one wire leading from the dynamo and grounded the other end of the primary, when a lamp, attached to the secondaries, immediately lighted up nearly to full candle power.

I considered this due to the electrostatic capacity of the cables, and believe it would be very disastrous, indeed, to the one who would be unfortunate enough to get himself in a position similar to the primary of the converter.

Perhaps the matter may be of interest to the New York Board of Electrical Control, as so many lead-covered cables are being used in New York at present. R. B. O.

LIGHTING THE VERMONT INSANE ASYLUM.

A PLANT was recently started in the Vermont Insane Asylum by the Giant Electric Motor Co., of Portland, Me., the work being carried out by C. B. Story, superintendent of the company. The plant consists of 300 lights furnished by two 150 light automatic dynamos, run by two 8x10 Atlas new automatic engines. The plant is so arranged that the machines run independently or together, a special interlocking switch being used. This running together is done without the use of rheostat or equalizer, and irrespective of any large variation in the speed of the machines. The plant includes also two arc lamps. The work was in charge of Mr. J. E. E. Emmons, and is said to prove very satisfactory.

Society and Club Notes.

PROGRAMME FOR THE N. E. L. A. MEETING AT MONTREAL.

THE programme for the meeting of the National Electric Light Association, at Montreal, has now been arranged by Secretary Beane.

BUSINESS.

The sessions of the convention will be held from ten o'clock in the morning until two o'clock in the afternoon; final adjournment for the day being had at the latter hour.

On the 8th of September the reports of the following committees will be read and discussed: Committee on Relations of Manufacturing and Central Station Companies; on Data; on World's Columbian Fair; on Legislation; on Underground Conduits and Conductors; on Safe Wiring.

On the 9th of September the following papers will be read and discussed: Discussion of T. Carpenter Smith's paper read at the Providence Convention, on the "Distribution and Care of Alternating Currents;" W. C. Warner, "Various Forms of Carbons for use in Arc Lamps;" Capt. Eugene Griffin, "Three Years' Developments of Electric Railways;" H. Ward Leonard, "A Central Station Combining the Advantages of both Continuous and Alternating Current Systems."

On the 10th of September the reading and discussion of the following papers: J. I. Ayer, "Some Details of the Care and Management of an Arc-Lighting Station as Practiced in the Municipality of St. Louis;" C. J. Field, subject to be announced; George A. Redman, "Central Station Lighting by Water Power; J. J. Burleigh, "Uniformity of Method in Keeping Central Station Accounts."

An executive session will be held on the 10th of September to elect three new members of the executive committee and to name the place of next meeting.

ENTERTAINMENTS.

The following is the programme arranged for the entertainment of the National Electric Light Association of the United States by the Citizens' Executive Committee, Montreal:

Monday, Sept. 7th, 3 P. M.—Opening proceedings of the convention in the Windsor Hotel, address of welcome by His Worship the Mayor and other distinguished members of the Reception Committee. 8 P. M.—Formal opening of the exhibition by His Excellency the Governor General.

Tuesday, Sept. 9th, 2.30 P. M.—Drive through the city and around the mountain. 8 to 11.30 P. M.—Conversazione at Redpath Museum, Molson Hall, McGill College.

Wednesday, Sept. 9th, 2.30 P. M.—Fire department display on Champs de Mars. 5 to 7 P. M.—Garden parties. 8 P. M.—Banquet at the Windsor Hotel.

Thursday, Sept. 10th, 2.30 P. M.—Through the kindness of the Harbor Commissioners, trip by boat down the St. Lawrence and the Lachine Rapids, stopping on the way at Caughnawaga. 5 to 7 P. M.—Garden parties.

Friday, Sept. 11th, 3 P. M.—Lacrosse match. In the evening promenade concert at Sohmer Park, through the courtesy of Messrs. Lavigne and Lajoie.

Saturday, Sept. 12th, 7 P. M.—Excursion to Quebec at reduced rates.

In addition to the above, yachting parties are being arranged for the entertainment of the ladies.

Reception Committee under the patronage of His Excellency the Governor General: Premier Abbott, Premier Mercier, Lord Mount Stephen, Sir Francis Johnson, C. J.; Sir Donald A. Smith, Sir Joseph Hickson, Sir J. W. Dawson, Hon. Henry Starnes, Hon. Judge Wurtele, Hon. Judge Davidson, Hon. Judge Loranger, Hon. Judge Taschereau, Hon. Judge Baby, Hon. G. A. Drummond, Hon. Judge Jette, Hon. Judge de Lorimier, Hon. Louis Beaubien, Hon. Joseph Tasse, Hon. —— Lacoste, Hon. George Duhamel, Hon. J. K. Ward, Hon. Edward Murphy, Hon. A. W. Ogilvie, Abbé Laflamme, Hon. James McShane, Mayor of Montreal.

Messrs. R. B. Angus, W. C. McDonald, E. B. Greenshields, A. E. Gault, Aldermen Martineau, Clendenning, Farrell, Hurteau, McBride, Perrault, Prefontaine, J. B. R. Dufresne, Gauthier, P. Dubuc, Cunningham, Robert, Grenier, Conroy, Thompson, Hamelin, Savignac, Shorey, Boisseau, Lamarche, Griffin, Rainville, Tansey, Malone, Stevens, Stevenson, Rolland, Jeanotte, Germain and Villeneuve.

Messrs. W. M. Ramsay, H. Barbeau, James Gillespie, Hugh McLennen, Louis Perrault, W. W. Robertson, Q. C.; C. J. Fleet, Q. C.; H. M. Crombie, C. Geoffrion, Q. C.; D. McMaster, Q. C.; H. C. St. Pierre, Q. C.; E. N. St. Jean, Q. C.; G. S. Mantel, M. P. P.; P. E. Lablanc, M. P. P.; Dr. S. Lachappelle, J. Peck, Frank Paul, R. Hersey, J. A. Pillow, P. H. Roy, Q. C.; G. C. Dunlop, James Burnett, S. Carsley, G. Lessard, M. P. P.; H. Hogan, H. Boisseau, M. Allan, A. Allan, Henry Lyman, Geo. W. Eadie, A. McPherson, H. Graham, E. W. Bottrell, S. C. Dawson, C. E. Sanderson, W. C. Munderloh, A. Rhodes, Alphonse Desjardins, John H. Q. Molson, Dr. Johnson, Dr. Harrington, Robt. Archer, President of the Board of Trade; Walter Shanley, P. A. Paterson, E. P. Hanniford, C. A. Dansereau, Sam'l Finley, R. Reford, G. W. Swett, ex-Mayor Grenier, W. W. Ogilvie, Phelps Johnson, Hector McKensey, Alexander McDonald, C. P. Sclater, R. White, M. P.; J. S. Hall, M. P.; K. W. Blackwell, F. R. F. Brown, W. E. Gower, Lucien Huot, Louis Givernaud, J. B. Tressider, E. H. Parent, L. A. Lesage, H. Wallis, T. E. Normand, M. P. P.; S. Mohr, Dugald Graham, D. A. P. Watt, C. Gartle, Dr. T. C. Brainard, J. B. Dawes, W. Cassils, D. McIntyre, D. Parrizeau, President of the Chambre de Commerce; L. J. Sergeant, T. E. Shaughnessy, R. Esdale, D. Preston, D. McNicoll, W. C. Van Horne, H. Scott, C. Hosmer, H. Bulmer, J. Chabot, A. Grant, C. Gould, W. Wainwright, E. K. Greene, C. Drinkwater, J. Hodgson, Victor Hudon, J. Cassils, D. Morris, A. T. Taylor, F. L. Wanklyn, W. Edgar.

Citizens' Executive Committee.—Prof. Bovey, chairman; John Kennedy, vice-chairman; P. W. St. George, vice-chairman; M. R. Redpath, vice-chairman; Richard White, treasurer; F. Fairman, acting treasurer; Prof. John Cox, hon. secretary; John Carroll, joint secretary; Prof. Nicolson, C. F. Sise, Prof. McLeod, A. J. Corriveau, L. B. McFarlane, H. Beaugrand, W. L. Laurie, E. C. Arnoldi, W. E. Christie, Geo. W. Sadler, J. S. Shearer, M. Perrault, James Kent, L. W. Toms, H. M. Linnell, S. C. Stevenson, Phelps Johnson.

Sub-Committee of Exhibit Committee.—Frank R. Redpath, chairman; John Carroll, secretary; Prof. John Cox, Frederic Nicholls, Prof. Bovey, A. J. Corriveau, John Kennedy, S. C. Stevenson.

Sub-Committee on Finance.—F. Fairman, J. A. Beaudry, H. Beaugrand, John Carroll, J. Cooper, A. J. Corriveau, J. H. Burland, H. R. Ives, F. R. Redpath, J. S. Shearer, R. White, Dugald Graham.

Ladies' Entertainment Committee.—Prof. John Cox, John Carroll, S. C. Stevenson, A. J. Corriveau, E. C. Arnoldi, W. E. Christie.

Transportation:—Delegates and others who contemplate attending the convention can obtain full information on matters relating to transportation by addressing the following local committees on transportation: Geo. F. Porter, Girard Building, Philadelphia; R. D. McGonigle, Pittsburgh; W. A. Kreidler, *Western Electrician*, Chicago; E. R. Weeks, Kansas City; J. I. Ayer, St. Louis; A. C. Shaw, THE ELECTRICAL ENGINEER, Boston, and C. O. Baker, 136 Liberty street, New York. Special freight rates have been granted by the Canadian Railroads, by which exhibitors are obliged to pay freight only one way, provided the goods remain the property of the original owner.

Reports of Companies.

FIBRONE MANUFACTURING COMPANY.

DEPUTY Sheriff Heimberger has taken possession of the factory of the Fibrone Manufacturing Company, at No. 300 Monroe street, this city, on executions for $19,704, in favor of the following creditors: Thomas H. Wheeler, $15,525; Kasebier & Vigelius, $1,583; Elisha H. Allen, $1,298; Frederick H. Allen, $1,298. The company manufactured fibrone and plasticon in competition with celluloid and zylonite. The company was incorporated in January, 1890, with an authorized capital stock of $60,000, which was increased in March last to $100,000. The company succeeded Richle & Steinberger, who had commenced the business five months previously. Mr. Steinberger, the patentee, continued as president. A large amount of money was spent on the plant and in pushing the business, which was increased so as to manufacture electrical and telegraphic appliances. Thomas H. Wheeler, the largest judgment creditor, is a director of the company and is of Hyde, Wheeler & Co., of Boston. On July 25 the company gave Mr. Wheeler a chattel mortgage for $14,748 on machinery.

MAHANOY CITY, PA.—The Electric Light Co. has declared a dividend of 2 per cent.

Appointments, Etc.

MR. EDWIN ELLIS has been elected general manager and treasurer of the Kester Electric Co., Terre Haute, Ind., and is now busily engaged pushing the interests of that concern.

MR. J. R. HARDY, late superintendent of the Hannibal & St. Jo. Railroad, has been appointed general manager of the Augusta, Ga., Electric Railway Co. He will work with Col. Dyer, and will have full charge of the entire operating department. He is to assume his new duties the latter part of this month.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED AUGUST 11, 1891.

Accumulators:—

Electrode for Secondary Batteries, L. Paget, 457,555. Filed June 5, 1890.
First claim follows:
An electrode for a storage-battery having an active core in contact with the connecting-lug of the electrode and a perforating conducting-envelope surrounding the core and insulated from the connecting-lug, except through the working-faces of said active core.

Alarms and Signals:—

Annunciator, W. R. McCann and S. S. Creider, 457,454. Filed April 23, 1891.
For announcements in the alternative as, for instance, "in" or "out." Specially adapted for use in hallways of office buildings or the like.

Conductors, Conduits and Insulators:—

Connection for Electric Conductors, J. Dillon, 457,761. Filed Jan. 16, 1890.
Includes a locked box or cover; especially adapted for underground conductors.

Distribution:—

Self-Regulating Electric Converter, T. Spencer, 457,407. Filed Dec. 17, 1890.
Winds a few convolutions of the wire of secondary coil in the reverse direction to that of the main portion of secondary. (See page 209, this issue.)
Claim 3 follows:
The method of automatically governing the effective electromotive force developed in the secondary coil of an electric converter, which consists in generating in that coil two opposing electromotive forces and causing the value of the less of these electromotive forces to diminish as the current flowing in the secondary circuit is increased.

Dynamos and Motors:—

Electric Motor, W. S. Hill, 457,534. Filed June 23, 1890.
A construction relating mainly to the field-magnets which are of the laminated type.

Dynamo-Electric Machine or Motor, E. M. Waring, 457,754. Filed Mar. 23, 1891.
Design and construction employing field-magnets of star-shape form with coils on their arms.

Galvanic and Thermo-Electric Batteries:—

Electric Battery, F. Poudroux, 457,430. Filed Mar. 6, 1891.
Employs two porous cells, a carbon cylinder in the inner porous cup, a hollow cylinder of zinc between the two porous cups, and a hollow cylinder of carbon between the outer porous cup and the battery jar. The solution between the inner carbon and the zinc consists of azotate of potash, binoxide of manganese, bichromate of soda, and sulphuric acid in water; the solution between the outer carbon and zinc consists of chlorhydrate of ammonia and azotate of potash.

Lamps and Appurtenances:—

Means for Suspending and Controlling Electric Lamps, S. Bergmann, 457,-578. Filed Feb. 25, 1891.
For incandescent lamps.

Electric Light Hanger, F. A. Weimer, 457,687. Filed Mar. 28, 1891.
For incandescent lamps. Adjustable to any desired height.

Electric Light Carbon, W. P. Eltringham, 457,763. Filed Apr. 27, 1891.
Specially adapted for arc-lights. Employs a composition of coke, pitch and borax, in about the proportions of 72, 23 and 5 per cent. respectively.

Measurement:—

Electric Meter, E. Meylan & W. C. Recknlewski, 457,453. Filed Nov. 10, 1890.
Described in THE ELECTRICAL ENGINEER of Mar. 18, 1891, Volume xi, page 329.

Miscellaneous:

Electrical Switch, H. H. Blades, 457,338. Filed Nov. 3, 1890.
A rheostatic switch for use with motors.

Electric Switch, H. H. Blades, 457,339. Filed Nov. 10, 1890.
A rheostatic switch for use with motors.

Magnetic Belting, T. A. Edison, 457,343. Filed Sept. 10, 1890.
Employs strongly magnetized iron pulleys and an endless belt of magnetic material formed of one or more wire ropes passing through transverse iron bars.

Brush-Holder for Dynamo-Electric Machines or Motors, C. O. Mailloux, 457,358. Filed Mar. 18, 1891.
Includes guiding and following devices for carbon brushes, spiral springs employed for "following."

Electric Steam Generator and Heater, W. Mitchell, 457,362. Filed Nov. 29, 1890.
Combines, with a water-reservoir, a heating device consisting of a series of layers alternating with water-spaces, a wire forming part of an electric circuit and wound on the layers within the spaces.

Safety Device for Electric Wires, J. H. Sedlmeyer, 457,374. Filed Oct. 23, 1890.
For giving an alarm at the power-station of an electric railway when the line wire is broken or crossed with another wire.

Electric Oil-Well Heater, C. W. & S. D. Robinson, 457,457. Filed Feb. 18, 1891.
For removing accumulations of paraffine, etc., which clog the flow of oil.

Automatic Electric-Circuit Switch, W. L. Silvey, 457,483. Filed Apr. 19 1889.
For opening the circuit of a street railway whenever the conducting wires become crossed or short-circuited.

Apparatus for Heating by Electricity, R. Kennedy, 457,561. Filed Nov 20, 1890.
Utilizes alternating currents for heating by an apparatus including a core forming an open or discontinuous magnetic circuit, a magnetizing coil and a body wholly or in part of iron to be placed in the incomplete portion of the magnectic circuit and heated by secondary currents induced therein.

Switch, S. Bergmann, 457,572. Filed Jan. 26, 1891.
An electromagnetic switch.

Wind Apparatus for Generating Electricity and Charging Secondary Batteries, J. M. Mitchell, 457,657. Filed Mar. 23, 1891.
Employs a wind-mill and an automatic device closing the working circuit when the dynamo generates a current of predetermined strength and breaking that circuit and making a derived circuit when the current falls below a given point.

Electrically Heated Oven, W. Mitchell, 457,745. Filed Nov. 29, 1890.
Oven provided with successive layers of non-conducting material and a wire which forms part of an electric circuit and wound between the non-conducting layers.

Electrical Matrix-Making Machine, W. W. Street, 457,752. Filed Nov. 15, 1890.

Electric Air-Pump, A. A. Dittmar & H. Falkenhausen, 457,762. Filed Jan. 23, 1891.
Claim 1 follows:
In an electric air-pump, suction and discharge compartments communicating with the pump-cylinders by valve-openings, in combination with solenoids placed over openings in the top plates of the compartments and having movable cores which pass through the openings in the said top plates and act as valve-stems, so as to open and close the respective valve-openings by electric currents conducted alternately through the respective solenoids.

Railways and Appliances:—

Pole Trolley and Stand for Electric Street Railways, T. E. Adams, 457,334. Filed June 11, 1889.
In addition to the trolley contact proper employs a spark-catcher arranged to press against the under side of the line-conductor behind the trolley.

Trolley Pole for Electric Railways, C. A. Lieb, 457,356. Filed Mar. 28, 1891.
A tubular metallic conductor is enclosed within the trolley-pole which may thus be made of light weight and sufficient ragidity.

Electric-Car Motor, C. O. Mailloux, 457,357. Filed Mar. 18, 1891.
Relates to construction of motor and manner of mounting it upon car. Motor-frame is in two parts; one, the upper, supported upon the car axle or truck, and the other, supporting the armature, detachable from beneath.

Friction Gear for Electric Car Motors, C. O. Mailloux, 457,359. Filed Mar. 18, 1891.
Claim 1 follows:
The combination, with the driven shaft, of the motor sleeved on suitable shaft or bearing and having its armature-shaft parallel therewith, an interposed eccentric sleeve, and means for rotating the latter to adjust the relation of the gear between the armature-shaft and said driven shaft.

Trolley for Electric Railways, S. H. Short, 457,377. Filed Nov. 6, 1889.
Designed to ensure an extended contact surface with the conductor and to be self-adjustable to compensate for wear.

Trolley, S. H. Short, 457,378. Filed Mar. 26, 1890.
Designed to secure automatically a uniform pressure between the trolley-contact and the line conductor.

Electric Railway, M. H. Smith, 457,382. Filed Dec. 16, 1887.
Employs two parallel positive conductors in one horizontal plane, two parallel negative conductors in another horizontal plane, and collectors arranged to make contact with all four conductors simultaneously.

Signaling-Telegraph for Cable Railways, T. A. B. Putnam, 457,565. Filed Mar. 13, 1889.
To give an alarm instantly in the power-house whenever the grip of a car has got fast to the cable so that it cannot be released.

Truck for Electric Motors, G. M. Brill, 457,599. Filed June 19, 1890.
Car has side-beams carried by the axle boxes; motor pivotally supported at one end on one of the axles and at the other end supported from the side beams.

Hanger for Trolley-Wires, N. Newman, 457,660. Filed Sept. 23, 1890.

Electric Railway, R. M. Hunter, 457,736. Filed June 21, 1886.
Relates to a conduit system having two working conductors insulated from each other and from the conduit and exposing oblique contact faces.

Telephones and Apparatus:—

Automatic Telephone System, H. V. Hayes & H. Sears, 457,477. Filed Feb. 3, 1891.
Designed to dispense with an attendant for very small exchange service.

Legal Notes.

A NOVEL SUIT AGAINST THE MT. MORRIS ELECTRIC LIGHT CO.

AN odd suit has just been brought against the Mount Morris Electric Lighting Company, and an injunction will be asked for to compel the company to discontinue the use of a couple of arc lights placed under the windows of a flat in Harlem.

Howard H. Morse has for several years past been living on the first floor of the Eisleben apartment house, at Lenox avenue and 125th street. Directly beneath the flat is the store of Boynton & Co. On May 19 last the dealers in the store had two electric arc lights hung from the lower part of the windows of Mr. Morse's flat, over the show windows of the store. Iron bars and wire stays support the lamps, which shed a brilliant light upon the goods displayed in the show windows.

They also throw a brilliant light into Mr. Morse's rooms, and to this free illumination Mr. Morse decidedly objects. He prefers to pay for his light when he wants it. His servants are afraid to clean the windows lest the electric current might knock them out or set fire to the property.

A third and greater nuisance, however, consists in the myriad of moths, bugs and other insects which are attracted by the intense light. Mr. Morse claims to have suffered tortures during the hot weather. If the windows are left open to admit the evening breezes the rooms become brilliantly illuminated and hundreds of moths come in and fly about the room. If the windows are closed and the blinds are pulled down to keep out the light and moths the rooms become hot and almost uninhabitable in the warm weather.

Mr. Morse asked the electric company to remove the lights, but his request was not heeded, and so he decided to bring suit to compel the company to remove the objectionable lamps and to pay him $500 for damages.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Josh Billings says you can't tell the extent of a man's business by the size of his letter head. His enterprise in advertising is a better test.

H. WARD LEONARD & CO.

In our last issue we gave a few details as to the important departure made by Mr. Leonard and his associates. The company has now secured fine offices on the fourth floor of the Electrical Exchange Building, in this city. The company is likewise making a very distinct innovation by the establishment of an Electrical Intelligence Department.

To any isolated plant the company offers at a very moderate subscription price ($25 a year) the privilege of corresponding upon any electrical subject of practical interest, and thus an isolated plant will be able to secure expert information as to its own plant and the best methods of operating it, and about any new electrical apparatus or methods and the principles underlying various devices and the prices thereof. For central station companies, whose queries would go further into steam engineering and methods of distribution, and would also cover business questions as to relations with consumers, systems of accounts, etc., the annual subscription charge for this electrical intelligence will be $50. This is an admirable idea, for any plant will get several times the value of the subscription price by placing before this company the matters upon which it desires information, data and statistics. As Mr. Leonard created and developed the Intelligence Department of the Edison General Electric Company, he has had the broadest possible experience in this line, since information of every character issued to those in the Edison Company has been issued by the Intelligence Department of that company. In case the expert judgment of the company be desired as to the comparative merit of various competing apparatus or methods, such expert judgment will be given by special arrangement, although the company prefers to merely supply full information under the subscription arrangement, and allows the purchaser to form his own conclusions.

H. Ward Leonard & Company will do no manufacturing and will do no supply business; neither will they, under any circumstances, act as the selling agents of any concern, directly or indirectly. They will, however, act for the purchaser, either as consulting engineers, supervising engineers, inspectors or purchasing agents. When acting in this way they will make the following charges, based upon the contract price:

For making preliminary plans, designs, determinations and estimates	1 per cent.
For making final plans and specifications	1 "
For drawing and executing contract on behalf of the purchaser	1 "
For supervising an installation made by another contractor	3 "
For inspecting and reporting on the work of another contractor	1 "
For acting on behalf of the purchaser in making the settlement with another contractor	1 "
For acting as the agent of the purchaser, from the beginning to the final settlement of a contract, including the making of estimate, plans, determinations, specifications, contract, supervising the installation, final inspection and report, and final settlement	5 "

It will be seen from the complete schedule given above that the purchaser will be able to obtain the services of this company for any portion of the work, and under terms which are so reasonable that there can be no question in the minds of those familiar with the subject that any purchaser contemplating the installation of electric plant would not only save a great deal of his own time and be spared a great deal of annoyance, but would actually effect a very material saving in retaining the services of a concern such as this to represent the interest of the purchaser.

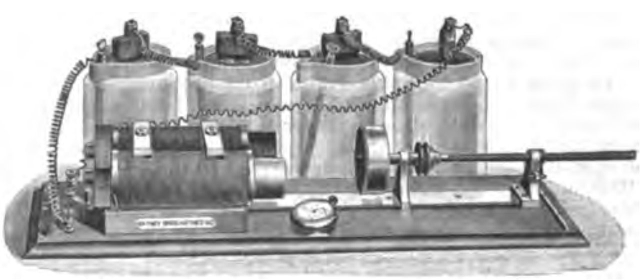
The various parent companies will also, no doubt, welcome the advent in the electrical field of an electrical engineering concern of this order, whose experience and ability is undoubted, and who are free from prejudice, and have no affiliations of any kind with any of the various electrical concerns. Any parent electrical company can refer a prospective purchaser to such a concern as this with confidence that any opinions given by it to the purchaser will be based on the honest judgment of those thoroughly competent to judge any practical electrical question.

The company will make a specialty of the transmission of power and the application of electric motors to such uses as necessitate the application of a wide experience in both mechanical and electrical engineering. Such applications of electric motors as are met with in elevators, pumps, hoists, mine tramways, printing presses, etc., are those which this company feels itself especially qualified to undertake under guarantee of perfectly satisfactory results. It may be added that, in addition to Messrs. Leonard, Vance and Harrison, already mentioned, the company will include Mr. C. H. Bloomer and Mr. A. Munning.

THE MATHEY WATCH DEMAGNETIZER.

The large variety of electrical apparatus embodying strong magnets in their construction which are now met with in daily life frequently affect watches not protected from such influence, and as a result many valuable timepieces are rendered practically useless. Fortunately, however, the cure for watches so magnetized is a very simple one and easily applied, involving principles which are thoroughly well known and understood. The simplest of these methods is the one which consists in revolving the magnetized watch within a magnetic field and gradually withdrawing it. By this method the magnetic polarity of the steel within the watch is constantly reversed and at the same time weakened, so that the watch finally is relieved of practically every trace of magnetism.

A simple apparatus for accomplishing this end has recently been brought out by Messrs. Mathey Bros., Mathez & Co., No. 16 Maiden Lane, this city. This, as will be seen in the accompanying illustration, consists of a plain horseshoe magnet which is energized by four Leclanché cells, which can be thrown in and out by means of a switch. The pole-pieces of the electromagnet are hollowed out so as to admit a cylindrical box within which the watch to be demagnetized is placed. This cylindrical box is placed at the end of a screw-threaded rod, which has a pulley mounted on it and which is supported at its rear end by a split nut, which can be opened by loosening the thumb-screw shown. The watch having been placed within the cylindrical box, the split nut is opened and the threaded rod run forward until the cylindrical box containing the watch is completely enclosed by the pole-pieces of the magnet. The split nut is then closed so that its thread gears with those of the rod. The little pulley is then worked by means of a bow, in a manner similar to that of the bow drill, and the revolution of the threaded shaft turns the watch quickly, while at the same time withdrawing it from the pole-pieces and hence out of the magnetic field. It is, of course, necessary to stop the balance wheel of the watch during the operation and to protect the watch by wrapping it in paper.



The Mathey Watch Demagnetizer.

One such operation, or, at the most, two, will deprive the watch completely of its magnetism and restore to it its original time-keeping qualities. The demagnetizer can be readily carried about and is placed in a fine mahogany case 2½ feet long by 6 inches high.

BALL ENGINES.

The Ball Engine Co., of Erie, Pa, has just shipped eight carloads of machinery to the Key West Gas & Electric Light Co., of Key West, Fla. The shipment comprised three large engines, two boilers, pumps, heaters, condensers, piping, etc. This local company propose to build one of the most complete plants in the South.

INTERIOR CONDUIT CO.'S AUTOMATIC SWITCH AND PROTECTOR.

IT has long been recognized that much inconvenience could be avoided and economy effected in the wiring of buildings if the circuit could be controlled from any number of points without the necessity of carrying the main current wires to the various points of control. A simple device by which this can be accomplished will therefore be welcomed by all electric light and motor con-

FIGS. 1, 3 AND 4.—NEW AUTOMATIC SWITCH AND PROTECTOR.

tractors to whom the problem just stated has often proved a vexatious one.

Such an apparatus has just been brought out by the Interior Conduit and Insulation Company, and is illustrated in the accompanying engravings. This consists of an automatic switch, Fig. 1, which is placed in the main circuit and which can be controlled from any distance by two push-buttons connected to it by ordinary bell or burglar-alarm wires. The method by which this is accomplished is very clearly shown in the diagram of connections, Fig. 2, the "on" button energizing a magnet which attracts the lever and closes the circuit, and the "off" button energizing a second magnet, which releases a trip and causes the switch lever to fall back and break contact Fig. 3 shows the push-button employed, which is of the ordinary kind.

In order to protect the circuit from any overload, the automatic cut-out, shown in Fig. 4, is inserted, being also indicated in Fig. 2. This cut-out or protecter can be set to open the circuit instantly at any fixed overload from one ampere upward. It is of special value, in view of the fact that the safety fuses ordinarily employed are usually made double the carrying capacity of the circuit in order to avoid their giving out and putting out the lights when there is really no danger. With the automatic cut-

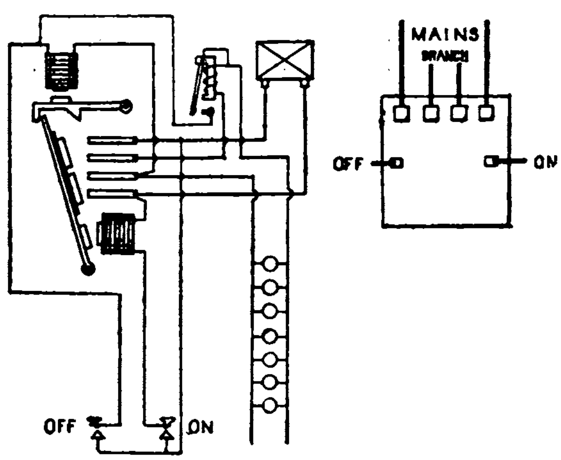


FIG. 2.—DIAGRAM OF AUTOMATIC SWITCH CONNECTIONS.

out, however, the circuit is ruptured at the proper time, but when the danger is over it can be at once restored to its original position without involving any delay or any cost for the renewal of fuses, which are rarely at hand when wanted.

MR. EUGENE DAVIS, formerly manager of the Brookline Exchange of the New England Telephone Co. has been appointed superintendent of Brookline fire alarms at a salary of $1,200. His new duties begin Sept. 1.

WESTERN ELECTRIC CO.

THE Western Electric Co. has just issued the July edition of its general catalogue. This handsome volume of over 300 pages is issued in an illuminated, stiff cover, and embraces within itself an enormous variety of electrical goods and apparatus. It is, in fact, an epitome of the electrical arts and applications, as is shown by the copious and careful index at the end. Among the leading specialties are the electric light dynamos and lamps, with other apparatus for that class of work, such as switches, fixtures, meters, shades, etc. Another large class of work is that of annunciators. Another is that of instruments for a large range of measurements. The section on wires is also large and important, and the same may be said about cables. A large number of tools and appliances are illustrated at the end.

THE ELECTRICAL SUPPLY CO., CHICAGO.

THE above company has recently removed to the corner of Michigan avenue and Randolph street, and with his wonted enterprise, Mr. F. S. Terry, the manager, has issued a dainty brochure showing the new quarters, which occupy the whole of a double five-story building, said to be the largest electrical supply house in the world. The illustrations show the building as seen from the street, and one of the busiest corners of its hustling, bustling interior. Noteworthy in this "busy corner" is a letter-box on which are the letters "F. S. T.," which represent the terse brief way in which Chicagoans, as well as New Yorkers, write and pronounce "first."

PHOSPHOR BRONZE SMELTING CO.

THE above company, of 512 Arch street, Philadelphia, whose Elephant brand trade-mark is so well-known and popular that it has lately been appropriated by the comic papers to represent the Republican party, has just issued a new and revised price list for a copy of which we are indebted to Mr. H. C. Lüders, the secretary. The list gives the fullest data as to roll and sheet, and particularly as to wire. A great variety of goods are included, and the different tables of weights, gauges, etc., are very useful.

HARRY ALEXANDER, ELECTRICAL ENGINEER AND CONTRACTOR.

IN order to obtain much-needed facilities for a rapidly increasing business, Mr. Harry Alexander has taken offices at No. 126 Liberty street, this city. Mr. Alexander devotes special attention to electric light and power installations and to wiring and construction work of all kinds. Mr. Alexander's experience, gained as inspector for the Thomson-Houston Electric Co., in Boston and the East, has made him fully acquainted with the requirements of first-class work. In his new quarters he will be enabled to undertake and carry out any work of this nature in the shortest possible time, and as all work is done under his personal supervision, the excellence of its quality is thus guaranteed.

RAPID TRANSIT PLANS FOR NEW YORK.

WITHIN the last two weeks some of the most important technical work required in a well-considered and comprehensive rapid transit scheme for New York City has been done by Chief Engineer William E. Worthen and William Barclay Parsons, his assistant.

One plan, that worked out by Mr. Parsons, makes provision for the pipe system under the pavement in Broadway by the construction of a subway in the middle of the street under the cable railway tracks and between the two railway tunnels. The pipe gallery or subway is made accessible from the railway stations, and not from the surface of the street through openings in the pavement, as has been heretofore reported. It is also designed to occupy the whole depth of the street to the foundations of the tunnel railroad.

The tunnels in this plan are designed to occupy the sides of the street next to the curb for a space of about ten or eleven feet; are to be "doubled-decked," or two stories in height, so as to accommodate two tracks, one above the other, and to be constructed of masonry walls and iron or steel roofs and cross-beams, with concrete foundations for the roadbeds. The motive force in both schemes is intended to be electricity, and the tunnels are to be made as light as possible with electric lights. In the plan referred to, the distinctive feature, however, is the provision of a permanent roadway for Broadway.

MR. J. S. CUMMINS, of Media, Pa., has become attorney for the Thomson-Houston Electric Co. in Chicago.

THE SIOUX CITY CORN PALACE.

THE electrical display and electric lighting were among the main attractions in the Corn Palace last year. This year both will be on a much more extensive scale. The buildings will be 380 feet long and 200 feet high, with daylight entirely shut out. About 3,000 incandescents and 50 arcs will be used for lighting and decorating.

The two leading attractions this year will be a South American exhibit in charge of representatives of each country, and the electrical display. For the latter alternating current of any potential up to 1,000 volts, direct constant potential up to 500 volts, and eight ampere constant current can be obtained in any quantity. Last year the model electric light plant and all goods displayed, except the ten horse motor, were sold. This year desirable exhibits from any manufacturer will be displayed and, unless sold, returned free of charge by the Sioux City, Ia., Electrical Supply Company, who have charge of all the electrical work.

The Palace opens October 1st, and the festival continues for seventeen days.

WESTERN TRADE NOTES.

THE HAY-HORN MANUFACTURING CO., of Chicago, report that they now have on hand orders for 6,000 bells, and that business is good. The Hay-Horn is a single magnet bell with an adjustable hammer.

THE SOUTHERN ELECTRICAL SUPPLY CO., of St. Louis, have just closed a contract for 235 miles of No. 10 insulated wire for fire-alarm telegraph service in St. Louis, also the necessary supplies, including 20,000 locust pins and all the equipment material. They have also received a large street railway order from Texas for No. 000 Okonite wire for feeder use.

MR. JOHN P. FRENZEL has just been elected president of the Citizens' Street Railway Co., of Indianapolis. He is also president of the Merchants' National Bank.

CHAS. T. LINDNER & CO., of San Francisco, consisting of Chas. T. Lindner formerly with the Edison General Electric Co., and J. H. Mathews, late superintending engineer of the Pacific Mail Steamship Company, have been appointed agents for the well-known Jenney lighting and power apparatus. The above-named gentlemen form a very strong combination, and will undoubtedly do well in handling this excellent apparatus, which is so well and favorably known.

THE WESTERN ELECTRICAL SUPPLY CO., of St. Louis, have closed the contract for the *Globe-Democrat* Building; the entire work is to be put in with interior conduits and about 1200 16 c. p. lamps will be installed, as well as telephone, telegraph and messenger wires and speaking tubes. R. V. Scudder is the secretary and treasurer

THC GREAT WESTERN ELECTRIC SUPPLY CO. are about settled in their new quarters, 201-207 S. Canal St. They report several large sales for K. K. weather-proof wire for which they are western agents. An agent for one of the large Electric Company's writes: "I recently had occasion to install a plant in a town where the trees and foliage were very thick; after testing all the leading brands of weather proof wire on the market, I decided that K. K. was best adapted for the work I had to do."

MR. W. W. GRISCOM, president of the Electro Dynamic Co., of Philadelphia, Pa., and also the vice-president of the Accumulator Co., was a visitor to Chicago last week. He spent several days here, during which time he was entertained by Mr. Wm. Hood, Western representative of both the above companies.

THE GREAT WESTERN ELECTRIC SUPPLY CO. are busily engaged in removing to their new headquarters in the Springer Building. They will carry on an extensive manufacturing business.

MR. W. H. MCKINLOCK, president of the Central Electric Company, is away on his well-earned vacation, and writes that he is finding both health and pleasure in the surf on the Jersey coast.

THE "PERFECT" INSULATOR, illustrated in these columns a few weeks since, sold by the Central Electric Company, is being received with very gratifying favor by construction men, and already a considerable number have been sold.

THE BALL CROSS COMPOUND ENGINE.

THE catalogue of the Ball Engine Co., of Erie, Pa., just to hand, contains excellent descriptions of the various types of engines manufactured by this firm. These engines, which have been specially designed for electric lighting, electric railways, and general manufacturing purposes, are built Simple, Tandem Compound, Cross-Compound and Triple Expansion, and each embodies features which give them special value. The cross-compound engine, which we illustrate in the accompanying engraving, was first designed about two years ago for the Edison station in Brooklyn, the company being convinced that a higher rotative engine could be successfully used when the work was distributed over two sets of crank pins and journals, than would be possible by the use of a single set of bearings of larger size, as is the case in the tandem compound; and this proved to be the case.

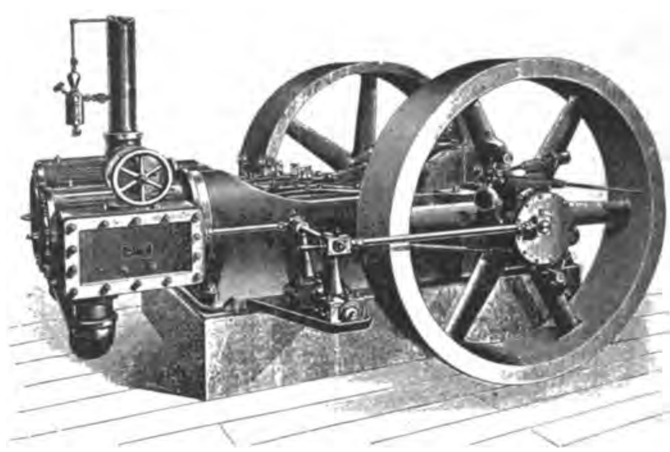
The crank-shaft is made of the best open-hearth steel, with the cranks opposite each other, one counteracting the effect of the other, so that the engine is perfectly balanced and capable of being run at a rapid speed with quietness and ease, and without heating.

The valves provide for quick admission of steam, and insure against all possible leakage. The pistons are as readily accessible as in the single-cylinder engine. The improved governor employed gives the closest regulation.

Instead of using an eccentric and strap on the low-pressure side, as is commonly done, an adjustable wrist-pin plate is bolted directly to the hub of the wheel. On this plate is the valve-driving crank-pin. This is found to be much preferable to the eccentric and strap arrangement, and on account of the smaller area of the crank-pin there is but little wear and but little oil required. The valve-operating mechanism is simple and reliable.

The Ball Company believe that the often-expressed desire of large central stations and other practice for an economical and reliable engine of medium power and occupying a comparatively small space, has been met by their cross-compound engine. Under the conditions of variable load generally encountered in service, they claim that their cross-compound will give more satisfactory results, and produce power at less cost, than any type of slow-speed Corliss engine, and considerably less than any single-cylinder high-speed engine.

As bearing out these claims, they point to the high economy



CROSS-COMPOUND ENGINE OF THE BALL ENGINE CO., ERIE, PA.

obtained with their engines in the Brooklyn Edison station, in which the consumption of coal is 2.75 pounds of coal per indicated horse-power, and three pounds per electrical horse-power.

The company also build a special cross-compound engine for electric railway work, and have a number of engines in successful operation in this service.

THE ADAMS ELECTRIC RAILWAY PATENTS.

THE Adams Electric Railway Co., of St. Louis, of whose claims and patents a full account was given some time since in THE ELECTRICAL ENGINEER, is sending notices to street railways of the various systems, warning them not to infringe Letters Patent No. 300,828, of June 24, 1884, granted to A. Wellington Adams for an electric motor for railway cars.

THE MINNEAPOLIS STREET RAILWAY COMPANY'S UNDERGROUND CONDUIT SYSTEM.

THE electric system of the Minneapolis Street Railway and the St. Paul City Railway Companies is, without doubt, the most complete, and one of the most extensive systems in the world. The underground conduit system employed by the Minneapolis Street Railway Company for carrying its mains and feeders has several times been mentioned in our columns. A series of tests having been recently obtained from the Street Railway Company, we take pleasure in bringing the matter before our readers again.

The novelty of the system employed throughout lies in the fact that there is not a wire in sight in the heart of the city except the overhead trolley wire. The feeders, mains, and track feeders are contained in a conduit underground, the trolley-wire connecting with the feeders by means of a sub-feeder through the hollow iron supporting poles. The conduit is located between the tracks and is built as follows: Two-inch plank, first treated by boiling in fernoline, is used for constructing a long trough of the desired size. This trough is so nailed together as to be continuous and without joints from manhole to manhole, a distance of 408 feet. The trough is placed below the surface at such a depth that the top is six inches below the paving blocks.

The conduit proper consists of a number of heavy paper tubes of the Interior Conduit and Insulation Company's make. The tubes, employed are one inch and one inch and a quarter, inside diameter, laid in the trough in ten-foot lengths and separated from each other and the sides and the bottom of the trough by rings or spaces. The tubes are made continuous from manhole to manhole by use of a telescopic joint. After the tubes have been properly put in place, pitch, liquefied by heat, is poured in, filling the interstices and leaving a series of highly insulated raceways with a solid insulating filling, impervious to moisture, around them.

The system is the first installation of underground conductors ever made in which bare copper wires were drawn into a conduit without other insulation than the conduit itself. There is, at the present time, about 60 miles of bare copper cable resting in the conduits, varying in size from 100,000 to 500,000 c.m. The insulation resistance on the entire amount of tubing, with overhead trolley and outlying feeders, as shown by actual test, is as high as 1,081,147 ohms.

A large amount of this conduit has been in service since September, 1890, and has not developed a single fault. The most emphatic and reliable tribute to the excellent results of this new method is found in the additional order for 200,000 feet of tube recently filled by the Interior Conduit and Insulation Co. The original order was for 400,000.

Some recent tests of the feeders in the conduits show an insulation resistance which is commendatory to the system and speaks for itself:

Feeder	A,	37,719,598 ohms,	Length,	3,122	feet.
"	B,	18,647,094 "	"	5,172	"
"	C,	2,251,122 "	"	8,048	"
"	D,	10,288,096 "	"	9,082	"
"	E,	1,790,898 "	"	7,219	"
"	F,	1,815,078 "	"	8,048	"
"	G,	1,488,031 "	"	5,172	"

The drop in the potential at the terminal of the feeders employed in the conduit is 5 per cent., while in the other systems, where the overhead feeders are used, 10 per cent., and over, is the result.

EXHIBITS AT THE EDISON CONVENTION.

Two exhibits at the Edison Convention last week attracted considerable attention. One was the Universal arc lamp burning in the room on the regular Edison circuit of the hotel. The light was pure, brilliant and steady. The other exhibit was the latest form of flatiron brought out by Mr. Carpenter, of the Carpenter-Nevins Electric Heating Co., of St. Paul. It was shown by Mr. G. H. Finn, the manager of the Edison St. Paul Station. A very thin wire is used imbedded in an under and upper coat of glaze, like that on certain domestic cooking utensils, and the wire brings the iron to a useful heat in about ten seconds, as soon as the circuit is closed. The same method of generating the heat is employed in a number of other appliances by Mr. Carpenter, and in every one of them with success. An extensive use of the apparatus is looked for, and the Edison men were most anxious to learn all about it.

THE ELEKTRON MANUFACTURING CO.

As we go to press, we are informed by this enterprising company that on account of the rapid growth of their business, due to the high reputation of their Perret motors and dynamos, they have found it necessary to increase their facilities. The first step has been to increase their capital stock from $100,000 to $200,000, and the new stock has been taken up for cash at par. The next step has been to move from Brooklyn to Springfield, Mass., into the Bullard Repeating Arms Works, the whole of which they have secured. The property consists of a brick building 52x40 feet, four stories high, with a three-story brick wing 125x40 feet. Another wing of the same size is to be added. The separate power-house contains 100 h. p., to which another 100 h. p. may be added.

The organization will remain as before, with W. D. Sargent as president; E. H. Cutler, general manager and treasurer, and F. A. Perret, chief electrician. Mr. W. E. Wright, of McIntosh & Co., Springfield, has been added to the board of directors. Mr. L. J. Harley, of the Smith & Wesson Works, becomes general mechanical superintendent. Mr. R. Watson will remain in charge of the business in New York, offices, store room and workshop being fitted up at 89 Liberty street.

NEW ENGLAND TRADE NOTES.

THE JENNEY STAR ELECTRIC COMPANY has recently been organized in Portland, under the Maine laws, with a capital of $50,000. The factory of the company is situated in New Bedford, Mass. Mr. J. A. Jenney is president; Mr. A W. Rounds, secretary and treasurer, and these two, with Mr. Bowker, of Messrs. Bowker and Tripp, are the directors. Mr. Jenney is well known as the originator of the Fort Wayne Jenney Electric Company, but has been actively engaged in New Bedford for the past year or two in perfecting the dynamos and motors which it is the purpose of this company to manufacture. Mr. Rounds is also president of the Russell Electric Company, of Boston, the manufacturers of the Russell disc carbon lamp, and the two companies will work to a certain extent in conjunction, though they will be entirely separate. The Jenney Star Company has no lamps, while the Russell Company has no dynamos, so that they can work well into one another's hands, in addition to other business. The purpose of the Jenney Company is to manufacture dynamos and motors from ⅛ h. p. upwards, and they already have large orders for numbers of the small motors. They are now equipping their factory at New Bedford with new machinery, engine and boilers, etc., and expect to be in running order in six or eight weeks. The dynamo will be entirely different from anything Mr. Jenney has yet brought out, and possesses many novel features, which makes it valuable.

THE RUSSELL ELECTRIC COMPANY, of Boston, are increasing their facilities for more rapid manufacture of the Russell arc lamp. The "Baby" lamp, built on the same principle as the large lamp, with disc carbon, is now ready to go on the market, and orders are being filled. The Russell Company are receiving the highest praises of their lamps from their customers, and orders are at present away ahead of production. The "Baby" lamp is designed for 45 volts and 6$\frac{3}{10}$ amperes, giving 1,200 candle power. It measures 27 inches over all, and only 23 inches from the hanger board to the bottom of the lamp. It will run from 10 to 12 hours, and can be used on any current from four to seven amperes, being provided with a regulating device to suit the current.

H. N. BATES & COMPANY, of Boston, general agents for the Hunter friction clutch, and general dealers in shafting, pulleys, hangers, etc., have decided, owing to the enormous increase in their business, to remove from their present quarter, at 1207 Pearl street, and will hereafter occupy the very handsome and capacious offices and store at the corner of Purchase and Congress streets, the exact location being 238 and 240 Congress street, and 182, 184 and 186 Purchase street. Here they will have a most commodious store on the first floor, measuring 80 feet long by 55 feet wide, one corner being partitioned off for offices and draughting room. They will also occupy the basement, which is the same size as the room above, and will altogether have one of the finest stores in Boston for their class of goods. The store is well lighted, dry and convenient, and is equipped with an extra large elevator. Altogether Mr. Bates is to be congratulated upon his change of quarters.

THE PORTER-LEAVITT ELECTRIC MOTOR COMPANY, of Providence, R. I., manufacturers of the small Porter-Leavitt battery motor, illustrated in our last issue, are being taxed very heavily to keep up with their orders. The business has grown upon them very rapidly, and abundantly proves that they are really filling a felt want. These little motors can be run with only two or three cells of battery, and are wonderfully efficient sources of energy for fans, small lathes, sewing machines, etc. The price varies from $8 to $10, according to size, which brings them within the reach of everybody. Fitted up as a fan, the Porter motor is invaluable in these dog-days, as it runs noiselessly and economically, and can be set down anywhere, on one'e desk, or at one's bedside, without inconvenience.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE

Electrical Engineer.

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THE FRANKFORT INTERNATIONAL ELECTRICAL EXHIBITION—V.

BY

Richard O. Heinrich.

MOST of the instruments contained in the collection of instruments of precision are well known. A number of improvements have been made, however, and it may be well to give a short description of the most important ones.

Fig. 1 shows a portable mirror galvanometer with lamp and scale. The light is thrown, by means of a prism, on a concave mirror within the coil, and from there on to the scale. On the mirror are fastened very light watch-spring magnets, in the well-known manner; a very short double-fibre suspension, and the lightness of the system of magnets make the instrument very quick acting and dead-beat. The respective positions of lamp and scale are a

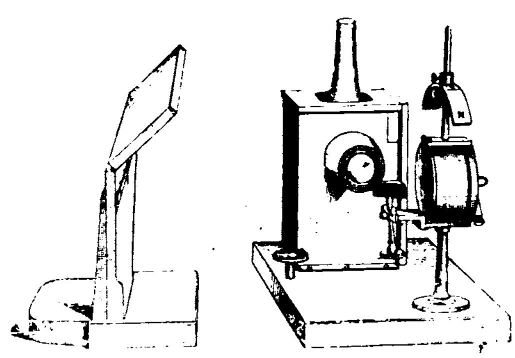


FIG. 1.—PORTABLE MIRROR GALVANOMETER WITH LAMP.

decided advantage for the observer. The whole combination is placed in a case of moderate size for transportation. Figs. 2 and 3 represent astatic mirror galvanometers of high sensibility. The galvanometer, Fig. 2, is intended for very accurate work in the laboratory. The coils are fastened on hinges, so that the astatic system of bell magnets may be easily reached. The mirror and the circular glass case may be turned in any direction, making the position of the reading device independent of the magnetic meridian. The coils can be used differentially, and small movable adjusting coils in the centre of the larger ones afford means for obtaining an exact balance if the magnetic action of the large coils is not precisely the same for each pair.

Fig. 3 shows a portable modification of an astatic mirror galvanometer. The central frame, carrying the coils, is made of solid copper with a narrow slot for the astatic bell magnet system. This frame serves at the same time as a very effective copper-damper. The instrument is very dead-beat, as shown by test, which proves that it is quite sufficient to have the greater amount of copper in the direction of the poles of the magnet in its zero position. In both the latter instruments the system of compensating and directing magnets is noteworthy. It consists of two magnets which are moved independently by a train of wheels; a very complete compensation of the earth's magnetism

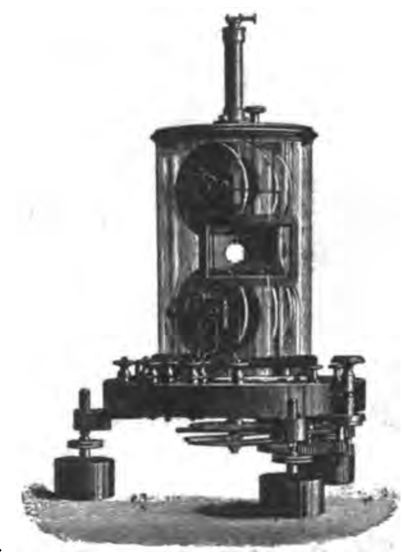


FIG. 2.—ASTATIC MIRROR GALVANOMETER.

can be effected by compensating first approximately with one of the magnets, and by making a final adjustment by placing the second magnet in a cross-position to the first.

The large slide-wire bridge, shown in part in Fig. 4, is a very complete and excellent piece of apparatus. The

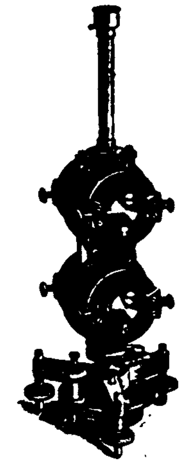


FIG. 3.—PORTABLE ASTATIC MIRROR GALVANOMETER.

wire is of platinum-iridium, two metres long and doubled up, so that the two ends come close together. The wire is protected against sudden changes of temperature, as, for instance (from the hand of the experimenter), by a perforated sheet of copper. The contact on the wire is made simultaneously from above and from below by two small platinum wheels. In the position shown in the illustration, the springs carrying the contact wheels are lifted by an eccentric. On raising the small handle on the slide contact, the springs press the contact wheels against the wire always with the same tension, preventing a kinking and notching of the wire. The fine adjustment is made by a

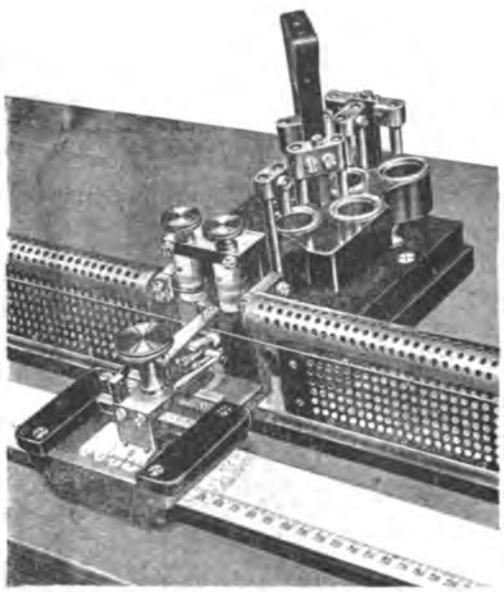


FIG. 4.—LARGE SLIDE WIRE BRIDGE.

rack-and-pinion movement. A very simple mercury commutator on an ebonite base allows of the commutation of the test and standard pieces.

GUTMANN'S ELECTRIC HEATERS.

BY

L. Gutmann

THE problem of electric heating has not yet received proper attention from electrical engineers on account of the alleged great cost of current as compared with coal or gas; nevertheless, proper analysis shows that there is considerable scope for electric heaters, as in the following cases, which have led the writer to construct a number of such devices for commercial purposes.

1. Electric heaters are a source of revenue in central stations operated by water-power; therefore they are especially adapted for supplying heat in mountainous countries and in cities around Niagara Falls. 2. To supply heat for local plants, such as large hotels, where there must be at all times ample power for lighting, running elevators, fans, etc. 3. For railway trains, to increase the safety of the public, and especially to prevent the setting on fire of cars after an accident. 4. To supply this commodity to residences or other places where comfort is the first, and cost a secondary, consideration.

In constructing electric heaters, continuous, alternating, pulsating, or intermittent electric currents may be used; but it will be found that the alternating or pulsating current, as in the distribution of light, will be the more advantageous one, as shown by the methods described below, which can be applied for this purpose:

1. Continous currents applied to a bare conductor or covered by incombustible material. 2. Alternating or intermittent currents applied to a bare conductor for raising its temperature. 3. Alternating, pulsating, or intermittent currents applied to magnets whose primary, secondary, or tertiary currents are used to heat a bare conductor or conductors imbedded in incombustible material. 4. Alternating, pulsating or intermittent currents applied to an open magnet whose flow of lines of force induce secondary currents in neighboring conductors. 5. Alternating, pulsating or intermittent electric currents whose primary, secondary or tertiary currents induce others in neighboring conductors by induction.

In the construction of heaters the following points at once force themselves upon the attention of the constructor:

a. To make a commercial heater we should use as small a current as possible, so as to have the least possible waste of energy in conveying the current to the place of consumption; *i. e.*, a device whose cost of supply is reasonable.

b. The law $C \times R$, which is in opposition to the condition *a*, according to which the heat developed increases as the square of the current, would indicate as a desirable feature the use of currents as large as possible. *c*. Also, that *C*, the current, can be made small and constant if *R*, the resistance, is increased; but in this case the pressure would necessarily have to be increased also. The aim of the writer has been to combine the contradictory conditions of *a* and *b* in constructing heaters, and while at first sight this solution seems impossible, it has been solved in a very simple manner, by means of apparatus illustrated in the accompanying engravings.

Fig. 1 shows diagrammatically such a system of heat distribution. From a central station alternator or pulsator, indicated by the collecting rings, the current is supplied to a converter at the place of consumption; the secondary currents may operate with a pressure of, say, 50 volts up to 200 volts.

The heaters are shown connected in parallel with one another, and are of special construction. In its simplest form the heater consists of an electromagnet whose magnetic circuit is closed by a grate or a corrugated conductor, and a screen separating the greater part of the electromagnet from the grate. A comparatively small current is supplied to the electromagnets whose magnetic circuit is partly closed by the grate in close proximity to the poles.

The action is as follows: The small current circulating through a coil of many turns around the laminated core establishes at its poles a field of rapidly varying intensity, which finds a path from one pole to the other through the

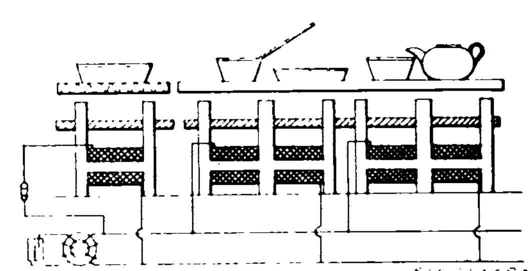


FIG. 1.—GUTMANN ELECTRIC STOVE.

grate, made of wrought or cast iron. The latter, not being laminated, will become heated rapidly, owing, first, to the heavy secondary currents circulating through the grate whose flat strips or bars and frame form a number of closed secondary circuits of very low resistance, located at right angles to the flow of lines of force of the energizing magnet; secondly, on account of eddy currents and hysteresis. The heat radiated is readily applied for heating or cooking purposes.

The perforations in the conductor, which at the same time may serve as support for the kitchen utensils while in use, have, besides the functions mentioned above, still others to perform. It will be evident that the grate develops the maximum heat at the lower surface and at points near the magnet poles; if the conductor is without perforations and forms a plate, the heat would have to penetrate through it to the other side, and that radiated at the side near the magnet would be apt to destroy the energizing coils. The perforations, therefore, supply a convenient

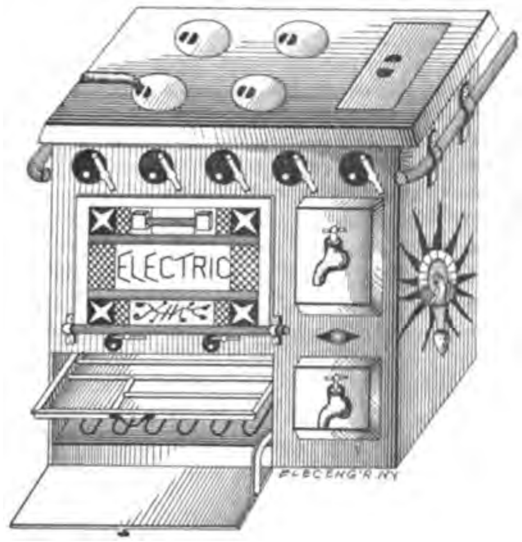


FIG. 2.—GUTMANN ELECTRIC STOVE.

passage for the heated air from the lower surface to the articles to be heated. To still further decrease the effect of heat radiation on the energizing magnet a screen of non-heat-conducting material is mounted on the limbs of the magnet.

Fig. 2 represents in perspective a heater or range, which, externally, has all the appearance of an ordinary stove, with the one vital difference that not all compartments are required to be heated simultaneously, as in the coal stove. They may be operated simultaneously, or each separately, every compartment being provided with a separate heater. The circuit is closed by the main switch on the right-hand side of the stove while the grates on top are separately controlled or turned off by the five switches which are seen below the guard rail, shown broken away. The baking oven and broiler are similarly controlled by the two switches mounted on the front side between the two compartments.

Fig. 3 is a cross-section of the same apparatus showing the application of a different kind of heater, in which the currents, alone or in combination with the magnetic circuit they establish, are used for heating purposes.

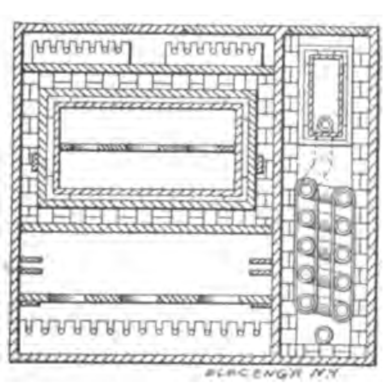
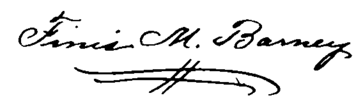


FIG. 3.—GUTMANN ELECTRIC STOVE.

To economize and preserve the heat as long as desirable inside the stove, the inner walls are lined with tiles, which has the further advantage for the operator over coal and gas stoves in that the air surrounding the stove is not much raised in temperature.

WEIGHING ELECTROLYTIC METER PLATES ELECTRICALLY.

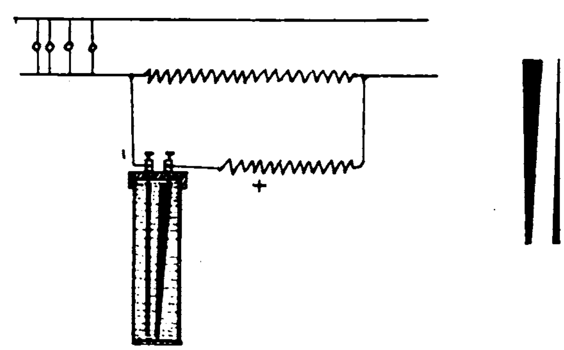
BY



THE demand for a means of measuring the amount of current consumed has given rise to numerous methods of measurement, of which the Edison electrolytic method forms one very generally used because of its simplicity, low first cost, and reliability. The fact that electric light stations which use a meter get more money for the same amount of current used is a strong one in favor of all adopting a meter, especially in plants of considerable output.

But one of the drawbacks to the electrolytic meter is the cost and care required in its manipulation, the renewal of plates, chemicals, and weighing, etc.

If we reduce the size of the plates and amount of chemicals used, and thereby diminish the cost of operating, we increase the degree of sensitiveness which is necessary to obtain accurate weights, and therefore multiply the errors to which we are liable. It is to obviate the necessity of weighing and to give a more accurate means of ascertaining the amount of current consumed that forms the subject of this article, and I hope soon to put the meter into practical operation.



FIGS. 1 AND 2.—WEIGHING ELECTROLYTIC METER PLATES ELECTRICALLY.

The method used is that of balancing resistances by means of a Wheatstone bridge or a differential galvanometer. The more we diminish the size of the electrodes used in the electrolytic method, the more we increase their resistance, and, therefore, the more perceptible any little change of that resistance and the more accurate our measurements. This will necessitate the diminishing of the strength of the current passing through the electrodes to avoid too great a deposit.

Fig. 1 shows a modified cell somewhat similar to the Edison cell. If we place two long and slender electrodes parallel in a solution and give them current, the greater amount of current will pass near the top of the fluid, and the deposit of metal will be unequal; the inequality of this deposit will be in proportion to the resistance of the electrodes and the strength of current, and may be balanced by inclining the electrodes to each other. This inclination must be in proportion to the resistance of the electrodes and fluid, and as the resistance of the electrodes is constantly changing, the inclination must also be changed in proportion. This change is effected automatically by taking an electrode of uniform size and tapering it gradually, somewhat like a wedge, as shown in Fig. 2, in front and side views, respectively. The resistance is uniform throughout its entire length. This wedge is placed with its flat end toward the top and with its edge toward another electrode of uniform size, and slightly inclined thereto, being closer at the bottom, and is connected to the positive terminal. As the electrode wastes away it increases in resistance, and as the distance between the top of the electrodes increases faster than the bottom, the deposit is thereby maintained uniform throughout their entire length. If the resistances of the electrodes are equal, they are placed with their nearest edges parallel.

Before placing in circuit, the resistance is balanced, as shown in Fig. 3, and the amount of deflection noted and tagged. It will be noticed that in this measurement we obtain simply the relative proportion of resistance between the electrodes, and the same deflection may be obtained between two pairs, though they differ greatly in size. I therefore have what I call a standard cell, through which

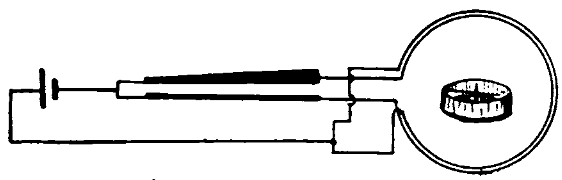


FIG. 3.—WEIGHING ELECTROLYTIC METER PLATES ELECTRICALLY.

a known current has been passed, say, the one thousandth part of one ampere for 1,000 hours; the electrodes are taken out and the deflection again noted. The difference between the two deflections must denote the ampere hour.

If now we wish to measure the amount of current consumed by 20 lamps, we would require electrodes with 16 times the amount of metal in the standard size. The deflection is noted, the resistances in shunt circuit being the same, and after an unknown current has passed an unknown length of time, the electrodes are taken out and the deflection again noted. The difference between the two deflections, multiplied by 16 (the difference in the size of the electrodes) times 1,000 (the part of current measured), will give the total current consumed. In this method the electrodes are paired and deflections noted and weights taken at the factory and numbered and tagged, and do not need to be separated when measured.

THE CAPACITY AND SELF-INDUCTION OF OVERHEAD TELEGRAPH LINES.

IN a recent note in the *Comptes Rendus* M. Massin calls attention to the lack of data with regard to the capacity and self-induction of overhead telegraph lines, caused by the difficulty of making the necessary measurements owing to the proximity of "live" wires. M. Massin, however, found means for obtaining these data for three circuits. A line, 18 kilometres long, iron wire, 3 mm. in diameter; two wires about 40 centimetres apart, and 4.5 metres from the ground. B line, 50 kilometres; C line, 50 kilometres; copper wire 2.5 mm. in diameter; two wires about 50 centimetres apart, and 5.5 metres from the ground. The following results were obtained:

Line.	Kilometric capacity in microfarads with respect to earth.	Ditto of the looped wires.
A	.0097	.0070
B	.0099	.0069
C	.0092	.0065

The two wires have, therefore, when looped, seven-tenths the capacity of either separately. On underground lines the capacity is exactly halved. The coefficients of self-induction per kilometre of looped wire were found to be as follows: Line A, .0121 henry; line B, .0129 henry; line C, .0025 henry.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—XII.

BY

Chas. Steinmetz.

Now we produce the curve of magnetic lag, k, either the cubic parabola, as explained before, or, better, here,—where we want to consider the phenomena over a larger range of magnetization,—the true curve of magnetic lag, as calculated from the experimental determinations of the magnetic constants of the iron used.

This curve is shown in Fig. 24 as k. For any value of *resulting* M. M. F., $F = \overline{\text{O F}}$ we get the *impressed* M. M. F. by drawing $\text{F K} \parallel \text{O A}$, as $K = \overline{\text{O K}}$.

The *secondary* M. M. F., L_1 is the horizontal line cut out between the curve of magnetic lag, k, and the quadrant of primary M. M. F., c, because of the parallelogram of M. M. F.'s. Therefore the secondary M. M. F., and the *secondary current* are given by $L_1 = C_1 = \overline{\text{O C}_1} = \overline{\text{K C}}$; and the *primary* M. M. F. or the *primary current* is, $L = C = \overline{\text{O C}}$.

The resulting M. M. F., F, gives the *induced* E. M. F., $E_1 = \overline{\text{O E}_1}$.

The *primary resulting* or *heating* E. M. F. is constant, because of the constancy of the primary current. Hence E lies on the quadrant e, and has the value $E = \overline{\text{O E}}$.

$\overline{\text{O E}_1}$ combining with $\overline{\text{O E}_e}$ to the resulting E. M. F., $\overline{\text{O E}}$, by the parallelogram of E. M. F.'s, $O\,E_1\,E\,E_0$, gives the *primary impressed* E. M. F., $\overline{\text{O E}_0} = E_0$.

$\frac{E_1}{C_1} = r_1$ is the secondary resistance, where this diagram corresponds to angle $\omega = \text{C O E}_0$ the difference of phase between primary current and impressed E. M. F., etc.

From this diagram, Fig. 24, we see that, when the secondary resistance increases from its value at short circuit, $r_1{}^0$, up to infinity, the resulting M. M. F. increases from the minimum F^0 up to a maximum value F^{∞}. The impressed M. M. F. increases, K traveling on curve k up to K^{∞}.

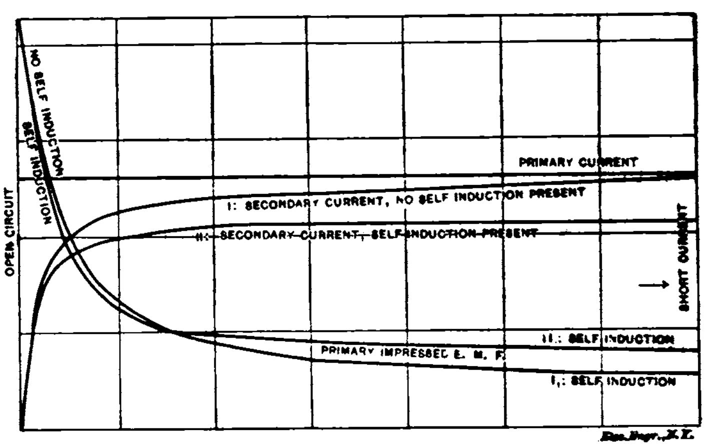


FIG. 25.

The phase of the primary current, and the difference of phase between primary current and impressed E. M. F., increase from about zero at short circuit, up to a maximum value for open circuit. The primary impressed E. M. F. increases from minimum, $E_0{}^0$ at short circuit, up to maximum $E_0{}^{\infty}$ at open circuit. The secondary M. M. F., L_1, and the secondary current, $C_1 = \overline{\text{K L}}$, decrease for increasing secondary resistance, from their maximum values $L_1{}^0$ and $C_1{}^0$ at short circuit, first slowly, then faster and faster down to zero.

This decrease of the current being first very slow, within a certain range, that is, below a certain maximum of resistance, the transformer compounds fairly well for constant current, and only when the secondary resistances overstep this value, does the secondary current fall off more rapidly.

For *decreasing* secondary resistance r_1, the ratio of the currents approaches an inverse proportionally to the ratio of turns:

$$\frac{C_1}{C} \sim \frac{n}{n_1} = 1, \text{ in our case.}$$

The *secondary* E. M. F., E_1 increases for increasing resistance, from its minimum value at short circuit, first almost proportionally to the secondary resistance, then slower, and reaches a maximum for open secondary circuit, that is, when L reaches the point of intersection of l and k; that is, $L^4 = C^4$.

Then the *magnetization* and the M. M. F. have reached its maximum also, $F^4 = \overline{O F^4}$. *The primary* E. M. F. varies from its minimum value, $\overline{O E_0{}^0}$, at short circuit, up to its maximum value, $\overline{O E_0{}^4}$ at open circuit.

The energy consumed by the converter, and also the energy converted by it, is a minimum for short circuit, increases with increasing secondary resistance, reaches a maximum and then decreases again to a minimum for open circuit, while in a constant potential transformer, the energy consumption and conversion steadily decrease from minimum permissible resistance down to open circuit.

For the constant potential transformer a short circuit is destructive, and open circuit the normal condition for no load. For the constant current transformer, short circuit is the normal condition for no load; open circuit, although it wastes no energy but that consumed in hysteresis and eddy currents, must be avoided because of its enormous waste of potential.

So far as the danger of destruction by overload is concerned, a constant current transformer is decidedly safer than a constant potential transformer, because the former cannot be overloaded to a destructive degree, it being able to transmit only a certain amount of energy, as its maximum capacity.

Fig. 24 shows the diagrams of the constant current transformer for the secondary resistances:

0. short circuit: $r_1{}^0 = .8$ ohms.
1. " $r_1{}^1 = 6$ "
2. " $r_1{}^2 = 12$ "
3. " $r_1{}^3 = 34$ "
4. open circuit: $r_1{}^4 = \infty$ "

The dependence of the secondary current, and of the primary impressed E. M. F. upon the resistance, or rather its inverse value, the electric conductivity of the secondary circuit, is shown in Fig. 25 as curves *I* and *II*.

From the diagram, Fig. 24, we derive the values:

		0.	1.	2.	3.	4.	
Primary current, C	=	65	65	65	65	65	amp.
Primary impressed E. M. F., E_0	=	23	58	79	147	214	volts.
Primary resulting E. M. F., E	=	20	20	20	20	20	volts.
Secondary current, C_1	=	64	58	54	39	0	amp.
Secondary E. M. F., E_1	=	2.6	19	60	130	208	volts.
Resulting M. M. F., F	=	156	1140	3600	7500	12480	amp. turns.
Angle of magnetic lag, α	=	30°	33°	25°	19°	16°	
Angle of phase bet. prim. cur. ω and impressed E. M. F.	=	0°	7°	12°	33°	66°	
Effective secon. energy, $\frac{E_1 C_1}{2}$	=	83	551	1620	2535	0	watts.
Eff. prim. energy, $\frac{E_0 C \cos \omega}{2}$	=	715	1821	2508	4062	2828	watts.

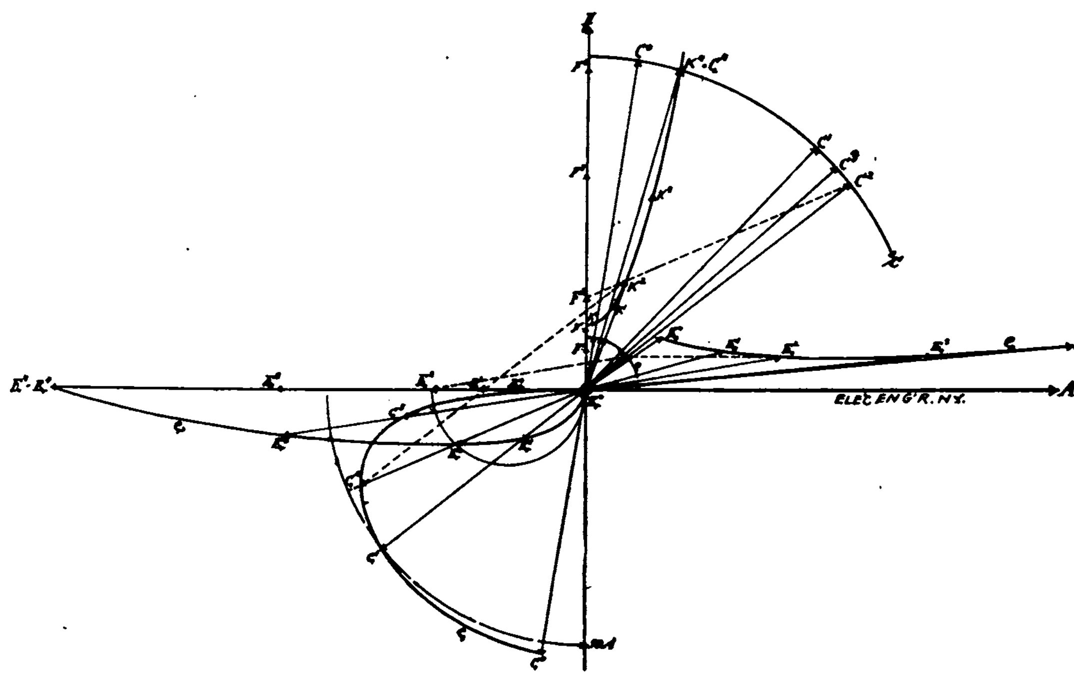


FIG. 26.

Ratio of transformation, $\frac{C_1}{C}$	=	.99	.89	.83	.60	0

As will be seen, the secondary current decreases with increasing resistance first slowly, then faster, down to zero. The E. M. F.'s, and the resulting M. M. F. increase with increasing resistance, up to maximum values. The angle of magnetic lag decreases, while the angle of shifting of phase between primary current and impressed E. M. F. increases with increasing resistance. The energy increases to a maximum and then decreases again. The ratio of transformation, $\frac{C_1}{C}$, reaches almost the ratio of the number of turns, $\frac{n}{n_1}$, for short circuit.

To secure still better compounding, the constant current transformers are generally built so as to afford a large magnetic leakage, that is, with a high self-induction in the secondary circuit.

In Fig. 26, the diagram of a constant current transformer is produced, which has a certain amount of self-induction in its secondary circuit.

The constants of the transformer are the same as in the transformer given in Figs. 24 and 25.

The self-induction of the secondary circuit may, for each ampere of secondary current, induce a counter E. M. F. of 4 volts.

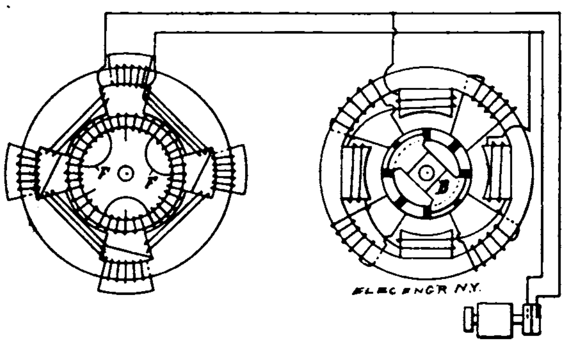
The primary current, C, and the primary M. M. F., L, lie again on the quadrant of the circle, c.

The primary resulting, or heating E. M. F., E lies on the quadrant, e.

Here the parallelogram of M. M. F.'s assumes a somewhat different form, because the phase of the secondary current is shifted against that of the secondary E. M. F., as explained before, in chapter VII.

GUTMANN'S ALTERNATING CURRENT MOTOR.

In alternating current electric motors there have appeared, up to the present time, only very small two-wire machines, while for larger powers either synchronous or Tesla three-wire motors have been used. The accompanying en-



FIGS. 1A AND 1B.—GUTMANN'S ALTERNATING MOTOR.

gravings represent a new type of motor designed for large capacity and adapted to operate on two-wire circuits, by Mr. Ludwig Gutmann, of Pittsburgh, Pa. Having noticed the very powerful effect of a short circuit in the armature of a continuous or alternating current motor, Mr. Gutmann has based the construction of his new motor on the every principle which is generally so detrimental, and is dreaded in any other motor. Figs. 1A and 1B represent, in diagram, two different motors. Fig. 1A shows especially the armature, while the field-magnet construction adopted in practice is shown in Fig. 1B. The armature shown is of the Gramme

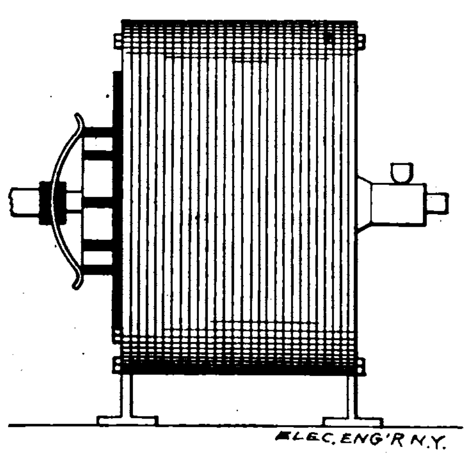


FIG. 2.—GUTMANN'S ALTERNATING MOTOR.

type, wound in the well-known manner, but the commutator is omitted, and instead there are three permanent short circuits, F, short-circuiting a portion of the armature winding. To prevent dead points it will be noticed that the short-circuited parts differ in number from that of the field-magnet poles. In Fig. 1A the field-magnet winding consists of primary coils connected to a generator or converter while a number of secondary coils are closed, each upon itself.

In Fig. 1B the arrangement is altered. The secondary coils are connected to terminals or to a commutator, in con-

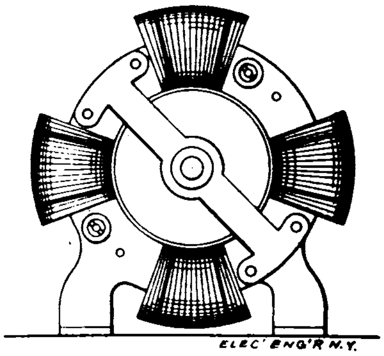


FIG. 3.—GUTMANN'S ALTERNATING MOTOR.

tact with which is a brush adapted to rotate with the armature. As the latter is repelled it shifts the position of the brush, and thus also the position of the secondary poles. It will thus be clear that the motor operates with a true alternating current field, which is influenced by a rotating secondary field of constant intensity, though intermittent in nature.

The action is as follows: The short-circuited coils, situated in a maximum magnetic field are repelled, and thus the brush, B, which is rigidly attached to the armature shaft, changes the position of the secondary poles which move in front of every short-circuited group or coil. As one of these approaches a field-magnet pole its power is weakened by the approaching secondary pole until the centre of the closed coil has passed that of the field pole. When this point has been reached the secondary pole has moved also; the primary pole again develops its full force and repels the coil in the same direction in which the armature has been moving. In this special form this process is repeated twelve times per revolution, and two of the coils are always active while the third one is inactive.

It will be noticed that the primary energizing circuit is permanently connected to the line, and that no circuit changers are connected with it, while the armature is of simple construction, and the commutator is in connection with low potential secondary circuits. The complete motor, of the iron-clad type, is shown in Fig. 2, while Fig. 3 shows an end view of a motor in which the energizing coils are partly external to the core.

SOME RESEARCHES IN MAGNETISM.

In a recent number of *Wiedemann's Annalen*, Karl Fromme states that some earlier experiments led him to the conclusion that the maximum value of the permanent (residual) magnetic moment P. M. attained by a body previously unmagnetized through the repeated application of the same magnetizing force P, could neither be raised nor changed by the application of a force equal to or smaller than P, and acting in the same direction. Later tests, however, had convinced him that this was incorrect. The magnetized bodies consisted of bundles of iron wire, pieces of wrought iron, and mild steel. One experiment was as follows: A piece of iron was magnetized to a constant value of P. M. by means of repeated applications of a current of one ampere and then subjected to the influence of a smaller current. In all cases the application of the weaker force due to the smaller current effected at first an increase in P. M. until it reached a maximum, and then a decrease through the original value to a negative maximum, and finally an increase again.

THE OERLIKON THREE-PHASE ALTERNATOR.[1]

The electric transmission of power for industrial purposes has now become an every-day affair, and, owing to the distances which in the majority of cases separate the waterfalls from the places where their energy is to be utilized, high pressures are necessary. Owing to the ease with which they lend themselves to transformations of pressure, and for other reasons, alternating currents are eminently adapted to the purpose, and when these currents are of the multiphase character, satisfactory motors are also forthcoming. The Oerlikon Works, which have for a long time made a specialty of transmission of power installations, are about to lay down several plants on the multiphase system, devised by Mr. C. E. L. Brown.

In Fig. 1 we have a general view of a 300 h. p. Brown "multiphaser," running at 150 revolutions. The armature circuits are arranged to give three alternating currents lagging 120 degrees, one behind the other. Each of the three circuits of the machine is wound for a pressure of 50 volts and a current of 1,400 amperes. The current output being large, rubbing contacts have been avoided by making the armature stationary and the field-magnets revolve. The armature conductors are 29 mm. in diameter, and consist of massive bars of copper, insulated inside abestos tubes, and buried in holes punched out of the iron close to the internal periphery. Foucault currents, which would attain enormous values in such large copper conductors, if they were arranged in the ordinary way, are by this device avoided; in fact, experiments made with "buried" conductors, 50 mm. in diameter, did not show that any power was lost by Foucault currents. This method of arranging the armature conductors is mechanically strong, and, as it enables asbestos to be used as an insulator, results in an armature which is absolutely incombustible. Moreover, the reduction in the air space, and the consequent improvement of the magnetic circuit, reduces the exciting current.

1. London *Electrician*.

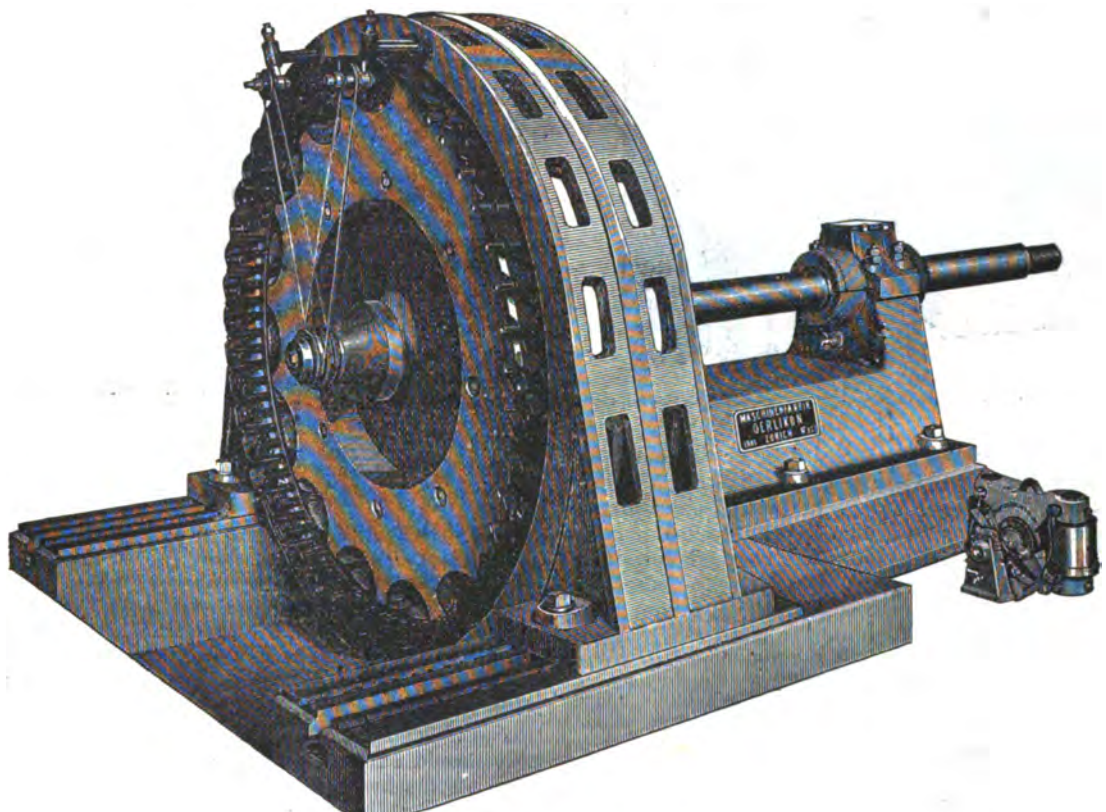


FIG. 1.—OERLIKON 300 H. P. THREE PHASE ALTERNATOR.

Corresponding to the 32 poles of the field-magnet, each circuit of the armature has 32 copper bars, connected in series by transverse pieces. There are, therefore, in all 96 (3×32) bars on the armature. The three circuits are joined up to each other in a manner similar to the three circuits of the Thomson-Houston arc machine. The armature core is surrounded by a cast-iron frame, and the whole can be moved along the bed-plate for cleaning and other purposes, leaving the field-magnet open to view, as shown in Fig. 2.

The exciting circuit is coiled round a sort of cast-iron pulley. Two steel rims, each armed with 16 horns forming pole-pieces, are bolted on to the pulley, one on either face, in the manner shown in detail in Figs. 3 and 4. This arrangement permits of the maximum utilization of the magnetic flux, and both the copper and the exciting current are reduced to a minimum. The construction of a field-magnet of this type is very simple, the 32-pole magnet being in only four separate parts, an inestimable advantage in a piece of moving mechanism subject to heavy stresses.

The exciting current is taken to the field magnets by means of two metallic bands, each of which passes round a grooved ring on the spindle, and round a pulley connected to a terminal. (See Fig. 1.) The armature is overhung, the massive spindle being carried on a double bracket bolted to the bed-plate.

A machine of this type can work equally well as a synchronizing motor, but it differs from an ordinary alternate current motor, inasmuch as it can be made to start without difficulty.

A few figures may not be without interest. The total weight of copper on the field-magnet is 300 kilogrammes; that is to say, a fraction of the copper usually required for other machines of the same size. To excite the machine so as to give 50 volts on open circuit, only 100 watts are required; that is to say, one-twentieth per cent. of the output. At full load, owing to the reaction of the armature, this amount is slightly increased, but it never exceeds a fraction of one per cent. At full speed, and with normal volts, the friction losses amount to 3,600 watts, about 1.6 or 1.7 per cent. of the maximum output. The $C^2 R$ loss in the armature conductors at full load is 3,500 watts. Adding all these losses up, we still have a commercial efficiency of 96 per cent. With such small losses the heating is, of course, quite negligible. The total weight of the machine without bed-plate is 9,000 kilogrammes.

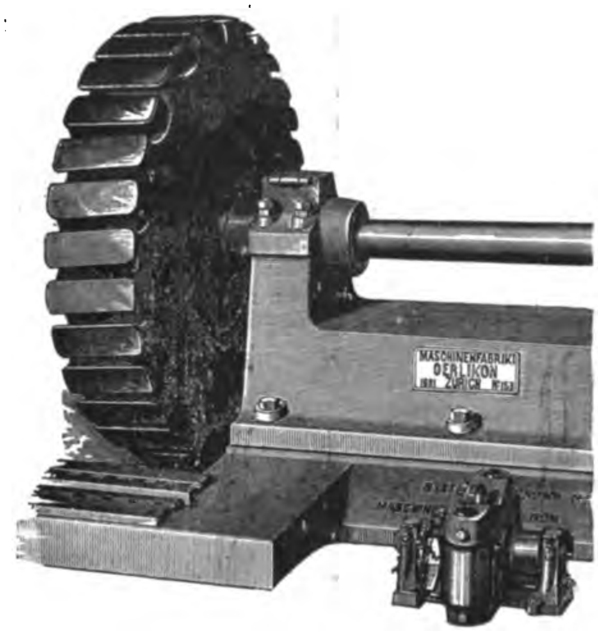


FIG. 2.—FIELD MAGNET OF OERLIKON THREE PHASE ALTERNATOR.

The Oerlikon Works have completed, or have in the course of construction, several dynamos of this type. First of all comes the Lauffen-Frankfort transmission plant. Machines are also built for 10 kilometres at Heilbronn and at Zurich; while three generators with vertical spindles, for coupling direct to turbines, and two motors with hori-

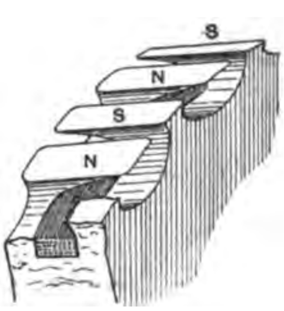


FIG. 3.—DETAIL OF FIELD MAGNET

zontal spindles, are to be employed to drive the whole of the machinery at the Oerlikon Works from a waterfall 23 kilometres distant.

THE GRASSOT ELECTROLYTIC METER.

THE electrolytic meter devised by M. E. Grassot has certainly the merit of originality. It consists of a silver wire 5 mm. in diameter, placed in a glass tube, and dipping for a distance of about 3 mm. into a solution of nitrate of silver. The silver wire is an anode to a cathode of zinc, and as it loses weight it is made to descend and pull round a drum actuating a train of clock wheels and indicating dials.

THE VIBRATION OF A WIRE TRAVERSED BY A CONTINUOUS ELECTRIC CURRENT.[1]

BY M. D. HURMUZESCU.

A FINE metal wire stretched between two supports, one of which is provided with a strainer or spring for regulating the tension, on being traversed by a *continuous* current begins to vibrate. The amplitude of the vibrations, which is at first very small, increases as the time goes on, and

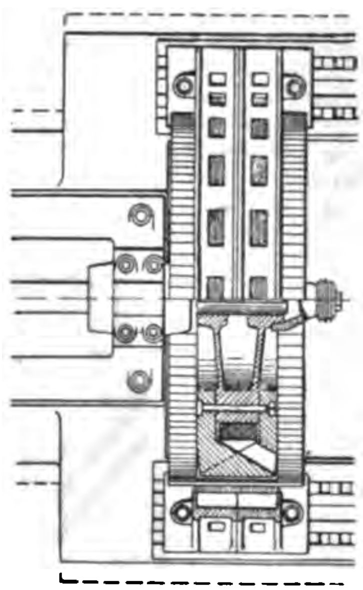


FIG. 4.—PLAN AND HALF SECTION OF FIELD MAGNETS.

quickly arrives at a maximum, which it maintains as long as the current is passing through, provided that the surrounding atmosphere remains in the same condition, or, at any rate, does not undergo any sudden change. The vibrations may thus continue indefinitely; they stop in a few seconds when the current is interrupted.

For a given tension, the amplitude of the vibrations seems to depend (according to the experiments which I have made up to the present) on the difference in the temperature of the wire and of the surrounding atmosphere. Now, as it is the intensity of the current which produces this difference of temperature in a given wire, the amplitude should vary according to the intensity. The explanation of this fact seems to me to lie in the interchange of heat between the wire and the surrounding atmosphere; this constitutes really a *thermic motor*, in which the energy expended is supplied by the current, and the principle of the conservation of energy can be applied to it.

Any cause producing a change, in any manner whatever, in the mode in which this interchange of heat takes place, will modify the phenomenon in some way or other. We can foresee that the finer the wire the more rapid will the vibrations be; this is confirmed by experiment. I repeated the experiment with wires of different natures, and found that the phenomenon always preserves the same character. If we put the wire in a large glass tube the movement is regular, because the wire is sheltered from the movements of the air. On closing the two ends of the tube, I observed no change in the rapidity of the vibrations. I hope soon to bring forward the law of this phenomenon from the points of view of the tension of the wire, the difference of temperature between the wire and the surrounding atmosphere, and the manner in which the interchange of heat between the two sources is effected.

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1. This research was made at the Laboratory for Physical Research at the Sorbonne, Paris. London *Electrical Review*.

ELECTRIC DISCHARGE IN VACUUM TUBES.

BY

Nikola Tesla

IN THE ELECTRICAL ENGINEER of August 12, I find some remarks of Prof. J. J. Thomson, which appeared originally in the London *Electrician* and which have a bearing upon some experiments described by me in your issue of July 1.

I did not, as Prof. J. J. Thomson seems to believe, misunderstand his position in regard to the cause of the phenomena considered, but I thought that in his experiments, as well as in my own, electrostatic effects were of great importance. It did not appear, from the meagre description of his experiments, that all possible precautions had been taken to exclude these effects. I did not doubt that luminosity could be excited in a closed tube when electrostatic action is completely excluded. In fact, at the outset, I myself looked for a purely electrodynamic effect and believed that I had obtained it. But many experiments performed at that time proved to me that the electrostatic effects were generally of far greater importance, and admitted of a more satisfactory explanation of most of the phenomena observed.

In using the term *electrostatic* I had reference rather to the nature of the action than to a stationary condition, which is the usual acceptance of the term. To express myself more clearly, I will suppose that near a closed exhausted tube be placed a small sphere charged to a very high potential. The sphere would act inductively upon the tube, and by distributing electricity over the same, would undoubtedly produce luminosity (if the potential be sufficiently high), until a permanent condition would be reached. Assuming the tube to be perfectly well insulated, there would be only one instantaneous flash during the act of distribution. This would be due to the electrostatic action simply.

But now, suppose the charged sphere to be moved at short intervals with great speed along the exhausted tube. The tube would now be permanently excited, as the moving sphere would cause a constant redistribution of electricity and collisions of the molecules of the rarefied gas. We would still have to deal with an electrostatic effect, and in addition an electrodynamic effect would be observed. But if it were found that, for instance, the effect produced depended more on the specific inductive capacity than on the magnetic permeability of the medium—which would certainly be the case for speeds incomparably lower than that of light—then I believe I would be justified in saying that the effect produced was more of an electrostatic nature. I do not mean to say, however, that any similar condition prevails in the case of the discharge of a Leyden jar through the primary, but I think that such an action would be desirable.

It is in the spirit of the above example that I used the terms "more of an electrostatic nature," and have investigated the influence of bodies of high specific inductive capacity, and observed, for instance, the importance of the quality of glass of which the tube is made. I also endeavored to ascertain the influence of a medium of high permeability by using oxygen. It appeared from rough estimation that an oxygen tube when excited under similar conditions—that is, as far as could be determined—gives more light; but this, of course, may be due to many causes.

Without doubting in the least that, with the care and precautions taken by Prof. J. J. Thomson, the luminosity excited was due solely to electrodynamic action, I would say that in many experiments I have observed curious instances of the ineffectiveness of the screening, and I have also found that the electrification through the air is often of very great importance, and may, in some cases, determine the excitation of the tube.

In his original communication to the *Electrician*, Prof. J. J. Thomson refers to the fact that the luminosity in a tube near a wire through which a Leyden jar was discharged was noted by Hittorf. I think that the feeble luminous effect referred to has been noted by many experimenters, but in my experiments the effects were much more powerful than those usually noted.

WHO SHALL DO THE WIRING?

BY

Ea. Harris

THE editorial on "Putting in Wires and Fixtures," in the August 5th issue of THE ELECTRICAL ENGINEER, convinces me that, like myself, others are believers in the oft-repeated statement that "electric light companies should leave the putting in of wires and fixtures to some one else" (in many cases to those more competent than the employees of the local company).

I am glad to see a growing interest in this subject, and would like to see a general expression of opinion through these columns from the various cities. There is no doubt in my mind that the New England town spoken of is "torn wide open" on the subject, as it is one that is causing various companies no end of trouble. Dallas was shaken from "stem to stern" when the new order of things went into effect. Previous to that time the local companies, in order to gain the supremacy, made the wiring a secondary consideration and the results can well be imagined. They could not afford to go to the expense of doing fancy work, as they were not charging for it, and consequently it was "fearfully and wonderfully done." The paramount idea in everybody's brain was to get the lights in and as soon as possible. This worked very nicely until the plant was installed, and all the lights put in that could be, and then the question arose as to what was to be done with the large gangs of wiremen. A number were discharged, but a very respectable number were retained, in the event that some one might want lights—which they did—but the employment of 10 or 12 well-paid men for the purpose of wiring two or three places a week soon played havoc with the receipts. The company passed through a series of vicissitudes, as all companies will that are run upon such an uneconomical basis, and finally passed into the hands of the parent company. A new order of things was inaugurated. It was given out that in future consumers would be expected to pay for everything, the company simply furnishing the current, and the consumer to get whom he pleased to put in his wires and fixtures. It was a difficult matter to overcome the existing idea that "it didn't cost anything to have lights put in," but they finally learned that it did, and after nearly two years' experience it is plainly to be seen that the step was a wise one for all.

The wiring was given over entirely to local contractors, who made it to their interest to introduce as many lights as possible, resulting in general good to all. Of course, abuses crept in, as a few people found out that they could have it done more cheaply by employing a discharged employee, or one who would do it after work hours; so much so that a concerted action on the part of the contractors and the local company resulted in the municipal authorities taking up the subject. A city electrician was appointed, ordinances and rules were drawn up and adopted, and matters began to brighten. All new work was done *strictly* in accordance with the rules, and even more so in special cases. All old, bad work was condemned and made new at the expense of the consumer, outside lines rebuilt, and in place of continued dissatisfaction on the part of the consumers, caused principally by lights going out, broken wires, burned-out fuses, etc. etc., "peace reigns o'er all."

The city electrician is absolute authority as to the merits of the work done, its safety being the first point considered, its general neatness and adaptability to the purposes intended being also considered. Inspection of the work is made during its progress before its use, and whenever any additions or alterations are made. The contractors are required to make application for the interior work, and submit diagrams showing the various circuits, location of cut-outs, sizes of wires, etc., etc., at the same time the application for the exterior work is made, and, upon completion of the installation, both the contractor and the company receive their official permit. The company make the connections with their circuits, the contractor makes his report to the company, and everything is lovely. Infractions of the rules are punishable by heavy fines and imprisonment. The result is apparent. The consumer sleeps securely in the thought that there is no danger of fire through bad wiring; the company knows how many, and where, lights are burning; the insurance companies rest easy, and the contractor knows that he has done a good job and no kick will be coming.

A year's experience under the new "régime" more than exceeds our fondest hopes, and has increased the list of consumers for the Electric Light Co. over 100 per cent. At the time that the new order of things began there were but 2,000 incandescents in use in the city. Now the total capacity—4,500—is taken, and the company will put in an additional 1,000 lighter in the near future. At the same time there were but 240 arcs in use, city lights and all; now, over 500. The power circuit was started in January, 1889, and up to the present there are 180 motors of various sizes, ranging from ⅛ to 20 h. p., on all classes of work. Where there was but one contracting firm then, there are three now, employing, at the dullest season, not less than 25 men.

One can but draw the very best conclusions from these facts, and they are, that it is best for electric light companies *not to do their own wiring.* While it would be rather embarrassing for companies in small towns not to do their wiring, it is very easy for companies in larger cities to adopt the rule and *stick to it*, as in nearly every large city there will be found competent persons to do the work. Of course, where it is not under municipal inspection, the company will only have to require the installation made under certain rules, and not allow it to be used until fully up to the standard. Nearly every city at the present time has a superintendent of fire-alarm, who can make it his duty to inspect wires. True, he may be far from being a practical electrician (God save the mark!), but he can see that the standard rules are carried out, and with a little co-operation on the part of the company and the contractors, he will soon be able to judge whether the splices are covered with tinfoil or with solder.

I have in my mind one company that believes in controlling the entire "shooting match," going so far as to carry a stock of bells, annunciators, etc., and doing a general supply and construction business. They have never been known to pay a dividend. I trust that the matter will be taken up by every one until an electric company putting in wires and fixtures will be a "rara avis."

ELTRINGHAM'S TEMPERED ELECTRIC LIGHT CARBONS.

In a patent just issued to Mr. Wm. P. Eltringham, the inventor describes a method of heating or tempering electric light carbons by the use of borax, which is claimed to increase their life. For 100 pounds of product the following ingredients are used in about the following proportions: Coke, 72 per cent; pitch, 23 per cent.; borax, any equivalents of borax, such as borate of sodium, sodium pyroborate, and disodic tetraborate, all commonly known as "borax," 5 per cent. This forms a mass, which is moulded and baked in the usual manner. The use of borax is claimed to increase the life of the carbon three hours and to give a stronger, clearer and whiter light than can be obtained with the ordinary carbon.

THE MANUFACTURE OF BARE AND INSULATED WIRE.

While wire in its various forms is employed probably in every industry, there is certainly none in which its use is so extensive as that of the electrical arts, and certainly none in which the consumption of copper wire is so great as in this.

We believe, therefore, that a short account of the methods employed in the manufacture of wire, as carried out in one of the largest wire-making establishments in the country, will prove of interest to our readers, having through the courtesy of Dr. F. A. C. Perrine, electrician to the company, been permitted to study the processes adopted by the John A. Roebling's Sons Company in their famous works at Trenton, N. J.

The treatment received by the wires, whether they be iron or copper, differs very little in the first stages of their manufacture. In either case a bloom of metal measuring four inches square by two feet long, and weighing about 135 pounds in the case of iron, and 150 to 200 in the case of copper, is heated in a Siemens gas furnace, and roughed in a three-high train, which reduces it to a rod one square inch in section. This is then passed automatically through guides into a set of rolls called the intermediate train, where its section is still further reduced, and the length of the rod increased proportionally. The rod then passes to the finishing train, which alternately rolls it square and oval; when passing from the square to the oval, the rod passes through a curved guide called a repeater; but when passing from an oval to a square roll, the rod has to be caught by a man who sticks it into the next succeeding pass. From the last pass it emerges as a round rod No. 5 B. W. G., at a rate of 1,500 feet a minute; as it shoots out from the rolls the wire is caught on a reel which automatically winds it into a coil, which is taken from the reel and bound with tie wires.

The finishing train employed at these works rolls nine different sizes at once, and is of the type known as the Belgian roll. In the other system of rolling most generally employed, the "continuous train," the wire passes straight through from roll to roll, whereas in the Belgian system all the rolls are in the same axial line. The advantages of the Belgian train are its simplicity of construction, since it is operated entirely without belting or gearing, either of which is always liable to cause a breakdown. On the other hand, one of the advantages of the continuous mill is that the loss of metal due to scaling is only one-half that encountered in the Belgian train. This is due to the fact that a shorter amount of rod is exposed to the air at one run. In fact, the scaling in the Belgian train amounts to as much as five per cent. of the total weight; nevertheless, this type of train is the one most generally employed at the present time.

Up to this point the treatment of iron and copper wire is practically identical, save that the copper is worked at a lower temperature than the iron and requires fewer passes through the roll. As the rods leave the train they are covered with scale, which must be removed before they can be passed through the draw-plate. This is accomplished by lowering the rods into tanks containing a weak solution of sulphuric acid, heated by steam. After being submerged for a considerable time, they are drawn out, rinsed with water and dipped in whitewash and baked, in order to dry them and to drive out the hydrogen which has been occluded in the cleaning process. This baking becomes necessary as the hydrogen makes the iron brittle. The rods then go to the wire-drawing mill, where they are "ripped," that is, drawn down by great reductions; after passing through three successive draw-plates the wire is annealed, again cleaned and coated with lime. The annealing furnaces in which this is done consist of iron pots set in fire-brick wells and fired by oil-burners from below. The wire is then again drawn down to the desired size.

The larger sizes of wire up to No. 10 B. & S. are drawn through chilled cast-iron dies, while the finer sizes pass through crucible steel dies. In the chilled dies the holes are simply reamed to correct size, and when worn away a little from the correct size are reamed out to the size larger. In the crucible steel die the art of the wire-drawer comes into play. These dies are usually kept at the same

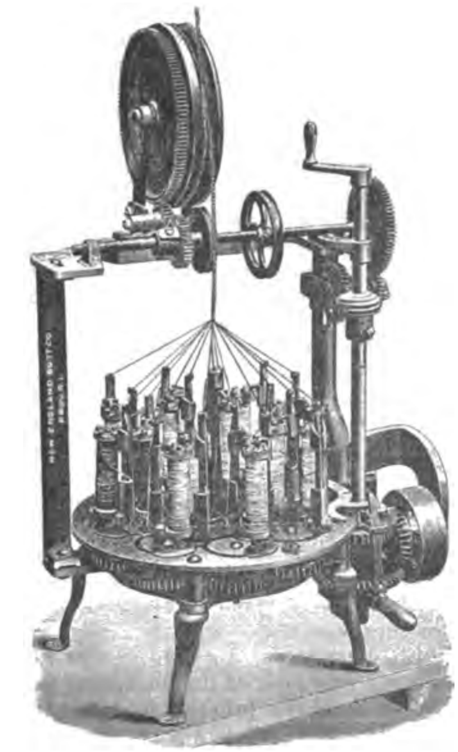


FIG. 1.—BRAIDING MACHINE.

size, and the wire-drawer must "set-up" these dies by hammering on the face and reaming out to the correct size.

The wire-block which draws the wire through the plate has a continuously revolving spindle, which is set in motion by a clutch thrown in by the attendant, and on the small sizes of wire is arranged to stop automatically upon the breaking or running out of the wire. When the product desired is galvanized iron telegraph wire, the latter, after being thoroughly annealed, is cleaned, baked and coated with lime, and then welded electrically into half-mile lengths, which are run through soldering acid and then through a pan of molten zinc; after which it is rolled up into a coil ready for shipping.

In the case of copper wire, unless the same be used for hard-drawn telegraph or telephone wire or trolley wire, it is first annealed, cleaned and carefully gauged. For magnet wires a variation of $\frac{1}{1000}$ inch is allowed during the process of manufacture, while for line wire a slightly greater variation is permitted; never, however, exceeding more than 2 per cent. from the correct size.

The bare copper wire drawn down to the various sizes required is now ready for the various insulating and protecting covers demanded in electrical work. Outside of the wire directly employed in the construction of electric machinery, the type of conductor most largely in demand is the weather-proof line wire. As a very high grade of insulation is not demanded in these conductors, they are simply passed through a hot compound, braided, and soaked again in the compound. They are finished with a polish in order to give them a clean surface and to prevent the adhesion of ice in winter. Larger sizes of this wire are shipped in coils and the smaller ones on wooden reels. No brazed joints of any kind are made in this wire, all the welds being made electrically on the Thomson welding machine, of which there are seven distributed in various parts of the Roebling works, which were among the very first to adopt these machines. The braiding is done on the machines illustrated in the accompanying engraving, Fig. 1. This represents the sixteen-strand braider of the New England Butt Co., a large number of which are in use in the works, besides not a few specially designed at the company's works for their own special uses.

Underwriters' wire is braided through paint, then externally painted, and polished by rapidly revolving plates pressed against the wire. This process hardens it and serves to keep out the water better.

Annunciator, office, and small cable wires, usually of No. 18 B. & S., are wound or braided with cotton, either single or double, dried and soaked in paraffine or other compound. The winding machine, illustrated in Fig. 2, also manufactured by the New England Butt Co., consists of two tiers of bobbins, which are kept revolving in opposite directions, and give the wire a double layer of cotton at one passage through the machine.

Magnet wire, after being carefully gauged, is electrically welded into uniform lengths of 150 pounds each. It is then covered by winding with one-ply cotton, as fine as No. 150. Most wires, however, are not covered with so fine a cotton, No. 100 cotton being more generally employed.

For this purpose only the best cotton is employed, and it is interesting to note that, notwithstanding the reputed superior quality of the Manchester, Eng., yarns, the American cotton has been found of better quality, being evener, whiter and stronger. Before being applied to the wire every length of cotton is tested in a special machine, and, if below a certain tensile strength, is rejected.

The manufacture of flexible cord also has received special attention at these works; this cord is composed of No. 30 B. & S. copper wires wound with cotton and twisted together, a tape of the finest Para rubber being afterward applied; then, after being again wound with cotton,

FIG. 2.—WINDING MACHINE.

it is braided in colors with silk or glazed cotton and finally twisted in pairs. The employment of the finest Para rubber for the tape is made necessary owing to the fact that it is the only quality of rubber which can be slivered down to a fine strip. Besides the various types of conductors above mentioned, there are many special wires, which are called for in different trades, and which are here produced.

Thus far we have treated only of single conductors, but the requirements of modern electrical distribution frequently call for heavier wires, either single, or grouped in the form of cable encased in lead. The lead-encased electric light cables are, as a rule, composed of strands consisting of wires not larger than No. 12 B. & S. These are wound with jute, cotton or paper, thoroughly dried and saturated with an insulating compound; after which the lead covering is formed around them by hydraulic pressure. The lead press employed for this purpose exerts a pressure of 7,000 lbs. to the square inch on a fifteen-inch

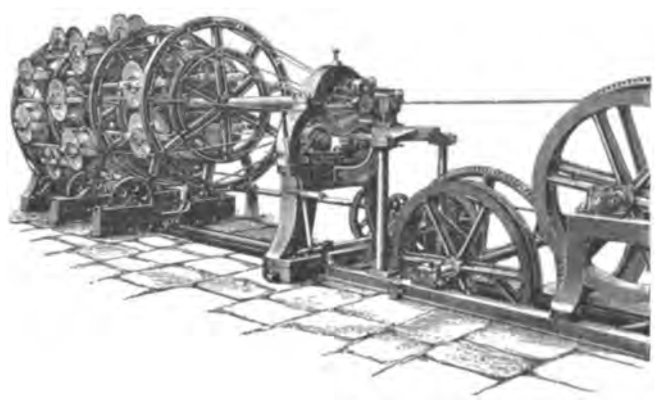


Fig. 3.—Cable Armoring Machine.

water ram, being the equivalent, therefore, to a pressure of 600 tons. This pressure is transmitted to a six-inch ram in the lead cylinder. The lead is not maintained at a molten state during this process, but, after being poured molten into the lead cylinder, is allowed to solidify. This practice is followed, owing to the fact that the lead as it passes from the liquid to the solid state passes through a state of shortness or brittleness, and the temperature is kept just below that point. Of the insulations mentioned above, the experience at the Roebling works indicates that cotton gives the least favorable results as to insulation, capacity, etc. Jute and paper are almost identical in these respects, but paper, on account of its solidity gives the highest spark-resisting power.

In the manufacture of electric light cables the paper is laid on as compactly and smoothly as possible, while for telephone cables it is applied as loosely as possible. In the latter case it is laid on in the shape of two strips laid straight along the wire and lapping each other, being held in place by a thread wound around them. This method gives a large air-space and small contact between wire and paper, thus insuring a low electrostatic capacity and high insulation. The cable is dried with the greatest care and lead-covered immediately, so as to prevent the re-absorption of moisture.

The advances made in the reduction of the electrostatic capacity of cables by the application of paper insulation is well illustrated by the fact that the specifications for telephone cables now call for a capacity of .085 microfarad per mile, whereas but a short time ago .18 was permitted. Recent cables laid in Boston, New York and Philadelphia, manufactured at the Roebling works, show a capacity of .082 with a No. 18 wire, while now .085 is required on No. 19 wire.

Some doubt has been expressed with regard to these cables as to whether they would retain their insulation at all, if, by reason of imperfect manufacture or carelessness in splicing, any moisture were admitted; but since there is no electrolyte present in dry paper, the effect of the small amount of moisture locally present, provided the sheath does not continually admit moisture, is that the dry parts of the cable absorb the moisture from the defective portion, and so quickly raise again the insulation to a workable point. As illustrating the correctness of this assumption, we may cite the case of a 100-conductor telegraph cable recently laid. Through the carelessness of the employees of the telegraph company the holes for the drawing-in wires were left unsoldered for some days. The cable, when spliced up, was found to have a dangerously low insulation resistance. The emergency of the case demanded that the cable be immediately put in service with ticker wires on the outside, with the proposed object of breaking down the cable if possible. These tickers are operated by alternate current at 350 volts. After a few days the cable was again measured, and was found to have improved in insulation resistance, which improvement has continued up to the present time. The cable is, indeed, now considered perfectly safe.

For submarine work the core or insulated conductor is tested under a pressure of 8,000 lbs. to the square inch. This pressure breaks up any air bubbles which may exist. This cable, used as a single conductor, is covered with tanned jute, tarred jute having been found to reduce the insulation of the gutta-percha. If used as a multiple conductor cable before juteing, the cores are twisted together in a cabling machine. The jute acts as a cushion to protect the core from the pressure of the armor wires; the latter are then laid on in an armoring machine, one type of which is illustrated in the accompanying engraving, Fig. 3. The armor wires are applied with as long a lay as possible, so as to give the cable the greatest possible longitudinal strength. Great care is taken with the galvanizing of the armor wires, and, wherever it is necessary to make a joint, the latter is regalvanized.

The above description, though necessarily brief, will serve to give a fair idea of the numerous processes which are required to enable the finished product to be placed upon the market. The demands of the present as to insulation conductivity and capacity are now so exacting that a fault in any one of these processes may lead to the rejection of the wire; hence the constant care required at every step. It is also worthy of note that our manufacturers have kept well abreast of the demands in every respect, in some cases even anticipating the requirements of consumers and offering a product superior to that which it was thought possible to manufacture and still possess all the necessary requirements.

SWINBURNE'S NON-INDUCTIVE WATTMETER.

Great difficulty has always been found in measuring power with alternating currents. The ordinary wattmeter,

Swinburne's Non-Inductive Wattmeter.

though accurate with direct currents when a correction is made for the power taken by the instrument itself, is of little value for use with alternate currents, as the time constant of the fine wire circuit is appreciable. If the pressure and current are in step, as is the case when an alternate pressure is applied to a resistance, such a wattmeter reads too low. If a pressure is applied to an inductive circuit, on the other hand, the reading may be much too high.

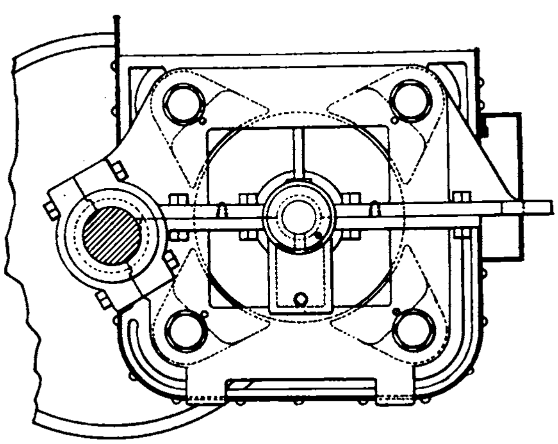
Messrs. Swinburne & Co. of London, have brought out a wattmeter specially designed to avoid these errors, which is illustrated in the accompanying engraving. The moving coil contains but few turns, and these are wound on a light mica frame. The coil is held by top and bottom stretched wires. External resistances are supplied, and these are wound with the alternate layers right and left handed; the time-constant of the fine wire circuit is thus made sensibly equal to zero.

Readings are taken by means of a torsion head in the usual way; but for measurements of minute powers, such as hundredths of a watt, a mirror is used. These wattmeters are wound to suit any range from 3,000 volts, and from 25 amperes downwards. They are said by the makers to read accurately on non-inductive resistances, and on inductive circuits in which the product of the pressure and current is 50 times the real power.

The wattmeter has the advantage over electrometer methods in that it does not involve the very serious troubles with resistances. Mr. Swinburne recently described an electrometer which reads power directly, which, though it does the work of the three voltmeters discussed by Messrs. Ayrton, Sumpner, and Swinburne soon after, unfortunately needs resistances. Dr. Fleming has enormously improved the instrument method by substituting ampere-meters, etc.; we thus have unimpeachable means of checking the wattmeter. If this wattmeter does what the makers claim for it, it will be exceedingly valuable to alternating circuit engineers.

THE MAILLOUX ELECTRIC STREET CAR MOTOR.

In railway motors of the usual construction it is necessary, when the armature is to be repaired, to raise a trap-



Mailloux's Electric Street Car Motor.

door in the floor of the car, and, after unbolting and removing one of the field magnets, to lift the armature out of its bearings, frequently a difficult and troublesome operation, and always taking a good deal of time.

In order to facilitate this operation, Mr. C. O. Mailloux, of this city, has devised an arrangement by which the armature may be readily removed for repair from beneath, the car being run over a pit for the purpose. This is accomplished without completely dismantling the motor or removing it from its support.

For this purpose the motor frame, as shown in the accompanying illustration, is made in two parts, one of which is supported upon the car axle or truck frame, while the other, upon which the armature is supported, is attachable and detachable from below, and may be lowered with the armature, leaving the main portion of the motor supported in its normal position. The field-magnet frame is divided into two parts, the lower of which supports the armature, and, when lowered, carries the armature with it, while the upper portion is supported upon the axle or frame, as usual.

It will be seen that the end plates are provided with journal bearings, and are mounted parallel to one another upon the car axle by sleeving the yoke-pieces. These are bisected and are bound together by the four parallel cross-rods which support the field-magnet pole-pieces. These rods form part of the field-magnet circuit and the energizing coils are wound upon them, the end plates thus having the function of magnetic yoke-pieces.

To protect the motor from dust and water, the yoke-pieces are connected by a thin shield, which is fastened to the flanges at their edges, and completely covers the working parts. This shield has an opening at the end, by means of which access may readily be had to the motor when necessary. It will be noticed that this shield and the detachable part of the motor are removed together when the two parts of the frame are disconnected one from the other.

THE McDOUGALL STORAGE CAR SYSTEM.

At the invitation of Mr. W. M. McDougall, we have had the pleasure of witnessing a trial trip of the storage battery car designed by him and which is now undergoing trial on the Steinway & Hunter's Point Railroad. Mr. Alfred D. Moulton, the general manager of this road, is a man of progressive ideas, and as such is thoroughly alive to the fact that the operation of his 33 miles of track by means of horses must eventually be accomplished by means of electricity in some form or other, and believing that the storage system embodies the least objectionable elements, so far as city traffic is concerned, he has readily granted Mr. McDougall facilities to demonstrate the feasibility of his system on that road.

The car is equipped with 100 cells of storage battery and a single motor with the McDougall flexible suspension. The system adopted by Mr. McDougall is such that the motor is left entirely free from shocks due to unevenness of track. It was fully illustrated and described in our issue of July 23, 1890.

The road traversed was something over 3 miles, but the ammeter readings, considering the condition of the track, were very low. The track, at best, is a very poor one and there are several sharp curves and considerable grades. On a level straight track the ammeter generally stood at 20 to 23 amperes, at times going as low as 15 where the track was good. On the curves the ammeter would gradually climb up from 55 to 90 amperes, according to the radius of the curve; but this was only a momentary reading, which immediately fell off to the normal value when a straight section was reached.

As showing the powers of the car, it may be mentioned that on the grade in Flushing avenue, which is perhaps equal to 3½ per cent., the McDougall car overtook one of the horse cars with a team which could not be induced to make the schedule time of the road. The electric car easily pushed the one ahead of it up the grade without the assistance of the horses, whose traces were slack during the whole time.

The car has what is called a 7-mile per hour equipment; that is, it will make 7-miles per hour over the road as it comes, good or bad. It will, however, easily run 10 miles per hour on a level straight track, and made 8½ miles per hour recently between the car stables and Silver Spring, counting the whole time of a round trip exclusive of the time that the car was actually motionless, but including the stopping and starting, the time being taken on a passenger trip. On the trial trip above mentioned Mr. McDougall was assisted by Mr. Townsend Walcott. Although the system embodies a double-reduction gear, the peculiar method of suspension made the car remarkably smooth running, and the noise and vibration were almost imperceptible.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XII. NEW YORK, AUGUST 26, 1891. No. 178.

The nomenclaturist should not seek the reward of his labors in the Patent Office.—Judge Coxe.

ELECTRIC LIGHTING STATISTICS OF THE CENSUS.

ALTHOUGH special provision has been made in the census for electrical statistics, various figures touching electrical industries have already been included in reports on other branches of industry, such, for instance, as those pertaining to street railway work. Another batch may now be found in the return on the "Social Statistics of Cities," prepared by Mr. H. Tiffany, under the direction of Dr. John S. Billings. The return deals with paving, shade trees, waterworks, sewers, police, fire service, street cleaning, and street lighting, and may be welcomed as an important contribution to the data of a very interesting class of subjects.

It would appear from Mr. Tiffany's figures that 309 American cities, with a population of 16,335,659, have for their streets 182,671 gas lamps, 53,696 electric, and 57,480 oil. These lights are maintained at the rate of one per 56 of the population, and cost annually $10,390,147, or 64 cents per head. In other words, each of the 293,847 lights costs $35.50 per annum. This table shows that gas lighting in the cities enumerated is over 60 per cent. of the total, and also brings out the fact that oil lamps are still so plentiful that they slightly outnumber the electric. But the fact that the census year is a period of transition is brought out in another table, showing that gas is now used exclusively for street lighting in only 13 of these cities, whereas electricity is exclusively used in no fewer than 125. It is noteworthy that a little further analysis shows the lights in these 125 cities to cost only $82 per year each, while in the 13 cities the gas lamps cost $23 each; so that the electrics cost at the rate of about four gas lamps, although they yield much more than four times the effective illumination.

Another table of interest is that containing the condensed figures of cities up to 100,000 inhabitants. In 278 of these with a population of 7,018,653 there are 35,191 electrics compared with 35,127 gas; and it is noticeable that with this much higher percentage of electrics the cost per head of population is only 60 cents, or four cents less than where the proportion of gas lamps is so much larger. Of these 278 cities, no fewer than 115 are in the class between 10,000 and 15,000, and there the average cost per head is only 56 cents. Evidently the electric light has proved its cheapness and efficiency in such communities.

Comparison between gas, oil and electricity would be more easily made from these tables if the candle power of the lights was expressed or integrated in some way. If this had been done, Mr. Tiffany would have saved himself one or two bad breaks. Thus he tells us gravely that: "The annual cost of each electric lamp varies from $440.67 in San Francisco and $237.25 in Boston to $58.46 in Denver and $68 in Chicago." The figure in San Francisco is wildly absurd. The rates were a "leetle high" when Mr. M. D. Law took out the pioneer plant there about ten years ago for the California Brush Co., but at the present time they are about the same as anywhere else. In all probability Mr. Tiffany has been misled by taking the price on a cluster of eight 2,000 c. p. lights and has put that down as the price per lamp. The comparison is as useless and wrong as would be the price for the tower lights that once lit up the whole of Madison Square in this city, when placed alongside the price for one of the many low-pole lights that now do the same duty. As an offset to this, we are told that the lights in Chicago cost only $68. Well, perhaps somebody believes that. We don't, and with all due respect to Prof. Barrett, never shall until more proof is adduced. "Municipal plant" figures are open to very grave suspicions.

The value of the electric lights is brought out by the table which furnishes details as to the number of lamps to the mile of street. Thus in New York, where there only 1,369 electrics to 25,483 gas lamps, there are 46.92 lamps to each mile. In Buffalo where there are 1,223 electrics to 4,377 gas, there are only 15.05 to each mile. Denver with 1,750 electrics, and no other lights, has only 2.31 to the mile. Portland, Me., 439 electrics, and no other, has 7.84.

We recommend these figures in their entirety to our readers, but believe a caution to be necessary in arriving at conclusions from them. As we have said, there are gaps that leave room for doubt. After all, we must wait until the statistics of Messrs. Foote and Foster make their appearance, which will, we venture to believe, by their very fullness, show how favorable the case for electric lighting is. Some of us were probably under the impression that the field for street lighting had been pretty well occupied. Mr. Tiffany's figures as to oil lamps, to say nothing of the gas burners, show that there is plenty to be done in the streets. It has been estimated that street lighting is about

5 per cent. of the whole. In the 309 cities enumerated, there are 53,696 electrics on the streets, against 240,151 gas and oil. If we admit the electrics to be the equal of the others, in the ratio of one taking the place of four, electricity will there have about captured 2½ per cent. out of the possible 5. Such being the case, there is no time yet to rest and be thankful. On the contrary, the situation should stimulate to greater activity than ever.

MUNICIPAL COAL YARDS.

It is with positive satisfaction that we find our good friends, the Nationalists of Boston, afflicted with a new craze, or rather, with the old craze in a new form. They have just been petitioning the City Council for the establishment of municipal coal yards which should supply all purchasers at cost price. This idea seems to have struck many people around Boston as a joke, but it certainly is not intended to add to the gayety of nations. Its object, indeed, is to add to the glory of Nationalism, for once Boston got its coal that way, who could draw the line?

In opposing strongly as we have done throughout the Nationalistic principles in electric lighting, we have had the feeling that while electric light men made the fight because their ox was gored, it would not be long before other industries would be attacked and the scene of struggle be shifted. There is going to be an irrepressible conflict right along these lines of the liberty of the individual and the public monopoly of every industrial function, and the fight might just as well come now as later. Every argument that has been used for freedom of enterprise, in the case of electric lighting, applies to coal, and it might be said that the Nationalists are really carrying their plan one step further, for, while electric light plants might be deemed to have a place within the category of public works, it would be rather a flight of the imagination to put coal yards there.

If not coal, why not oil, and if oil, why not bread, and if bread, why not games? By all means, let this thing be pushed to the issue, and fought out.

FUSIBLE CUT-OUTS.

While the many rules and regulations of various boards of fire underwriters have, with good reasons, been so framed as to insure the thorough insulation of the circuit at all points, and the erecting of wires properly proportioned to carry the currents with safety and without undue heating, there has, we believe, not yet been given sufficient attention to another essential safety device which is now in almost universal use on electric circuits. In the early days of the art, conductors were frequently guarded from the effects of dangerous currents, produced accidentally, by the insertion of electromagnetic cut-outs. These, however, were soon superseded by the more simple and far less expensive fusible cut-outs. The latter have indeed done good service, but if electrical distribution is to be made safe in the future it will be necessary to change certain vicious methods which are, we are inclined to believe, not on the decrease at the present time. We refer more particularly to the indiscriminate use of fuse wires, the carrying capacity of which is frequently an unknown factor of the safe limits of the conductor it is supposed to protect. Electrical engineers will frequently have encountered in their practice instances in which fuse wires actually carried currents 100 per cent. in excess of that for which they were intended, and for which they were sold. If to this we add the fact that wiremen frequently reduce the carrying capacity of fuse wires to accommodate circuits of lesser capacity, by paring down the wire with a knife, it will be evident that a radical change in the employment of this useful device is necessary. A good step in advance in this direction could, we think, be made if the use of fuse wire unprovided with proper terminals and with the carrying capacity stamped thereon were prohibited. Of course even this will not always guarantee the cutting-out of a circuit at its proper limit, if the fuse wire itself be not of the proper quality; but that is a defect which can be guarded against by obtaining supplies from reputable manufacturers and testing them, in addition. That the importance of this subject is thoroughly realized in certain quarters is evidenced by the article appearing in another page descriptive of the large variety of fuses employed in the work of a well-known electrical company. There is no reason why a fuse wire cannot be constructed to operate within a small fraction of its desired current-carrying capacity. The return to electromagnetic cut-outs, as we have noted recently in some instances, is, if not a step backward, at least one hardly warranted by the facts.

INSURANCE INSPECTION REPORTS.

We have had an opportunity within the last few days of looking over some insurance inspection reports on a city not far from New York, and are surprised to see so many things referred to and criticised that one would expect to be obsolete after so many years of experience in the art of wiring. Thus, for instance: "The service wires entering this building were found passing through the same hole in the woodwork." In another place: "Wires for arc lamp in front of store found twisted together and lying on wood cornice." Elsewhere: "The wiring in store is very poor; underwriter's wire is used fastened in a number of places with metal staples and the wires hanging about in a loose manner." Fortunately the current has been shut off there, and will stay shut off until the place is rewired. In another place: "The wires enter the building through a metal-roofed window; no bushing is used to protect the insulation, and no means taken to prevent water from entering the building." In several instances the wires are reported in close contact with the gas pipes, even being twisted around them. We note also the use of single-pole cut-outs. Much of the work is not available for inspection, for the reason that it is imbedded in plaster. The situation is summed up in the remark: "A great deal of the work shows either gross carelessness or utter incompetency." We can only hope that every inspector will be sustained who puts his foot down sternly and is severe in his condemnation of bad work. There is no excuse that will hold, and none should be listened to. The welfare of the whole art demands the use of the best materials and the most approved methods; and it does not take long to find out what they are.

NEW FORMS OF ELECTRIC HEATERS.

The statements that have been made from time to time to show that electric heating cannot compete in economy with the methods now in general use are, we think, destined to be as rudely thrust aside as were those by which it was attempted to show that electric lighting could never compete with gas. While the cost of electric lighting may hardly be said to have yet reached the low point of the cost of gas except on the candle-power basis, it is nevertheless a magnificent success commercially, and the time is not far distant when electricity for lighting purposes will be sold for less than gas. The course which electric heating will pass through will be similar to that of the electric light. At first scoffed at, it is now being introduced not only for the special purposes of heating electric cars and steam railway trains, but we know of an actual case in which a large block of apartment houses is being equipped with electric heaters. Naturally, electrical engineers are beginning to pay some attention to the apparatus placed in their hands for this class of work.

In this issue Mr. Ludwig Gutmann describes a new type of electric heater in which he utilizes the iron core of an induction coil as the secondary itself, and thus obtains the entire heat available in the energy of the current by turning to useful account the heat due to hysteresis and eddy currents, as well as that generated in the core used purely as a secondary.

THE AREA OF SMELL.

Few people realize how great is the work of the electric car, and the cable car, too, in reducing the number of horses kept in our cities. President Wilson, of the New York Board of Health has recently said that the Health Inspectors find that the total number of horses in this city is 50,000. The mere substitution of the cable on the Broadway and Third avenue lines will dismiss about 6,000 of those from service, and the streets will be proportionately cleaner and longer lasting. Then the stables are banished also, and with them go many nuisances that no care can keep under. The horse car stables in this city all have their area of smell, and what that smell is a good many passengers on the New York Elevated road know intimately. The stench from the stables at Fiftieth street and Sixth avenue makes itself felt pungently for hundreds of feet around, and at some times much worse than at others. The public does not yet resent these nuisances as it might, for the horse car has been an enormous boon, but by-and-by they will not be tolerated.

Electric Weighing of Electrolytic Meter Plates.

In a recent issue we published an ingenious type of electrolytic meter devised by Mr. Tesla, in which, it will be remembered, the plates, instead of being removed from the cell, taken apart and weighed, were gauged electrically by measuring the change in electric resistance caused by the reduction or increase respectively in area as the result of electrolytic action. In this issue Mr. F. M. Barney describes an arrangement in which a similar method is employed to determine the loss or gain in weight in the respective plates. While the removal of the meter plates from the customer's premises to the station and their weighing may not involve so great an inconvenience as might be supposed, it is, nevertheless, true that a method by which this present drawback can be avoided would give an additional value to this type of meter. A simple ohm-meter kept permanently on the premises of the consumer or carried about by the meter man would suffice to give the indication required for calculating the proper charges for this system.

The Oerlikon Three-Phase Generator.

The experiments on the transmission of power from Lauffen to Frankfort were expected to call forth considerable ingenuity as well as originality, not only in the methods of distribution, but also in the detail of the apparatus employed. Fortunately the hands in which this power transmission has been placed have been thoroughly equal to the necessities of the case, and the details as they are published from time to time leave little doubt of the ultimate success of the plant. In this issue we describe the three-phase alternator designed by Mr. C. E. L. Brown the able engineer of the Oerlikon Works. The design of this machine is excellently worked out and shows the wide range which can be drawn on to work out a particular case.

Alternating Current Motors.

The variation which is possible in continuous current apparatus, of either the generator or motor class, is comparatively limited, but as has been proved to be the case in other forms of apparatus employing the alternating current, the alternating motor is susceptible of a considerable number of modifications in detail. This is well shown by the excellent résumé of the subject given by M. Hospitalier and printed in another column. The classifications adopted and the examples of each will serve to point out to the student the various directions in which work can still be accomplished in this field.

The Park Place Disaster.

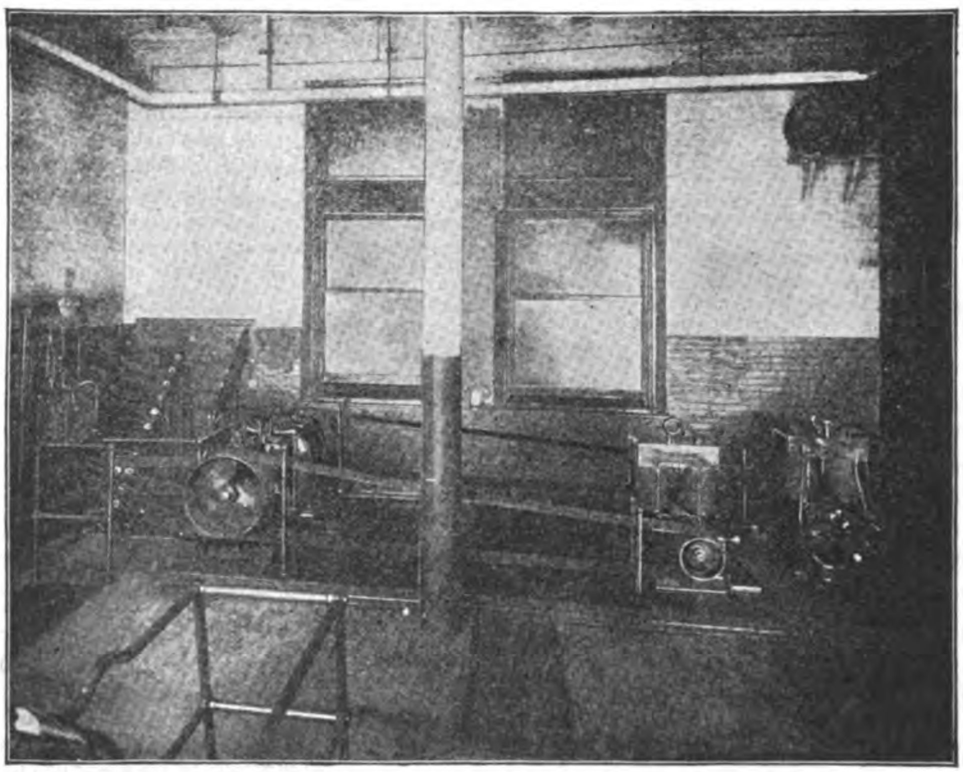
Our readers will have become aware, through the newspapers, of the great and sad disaster that visited Park Place, in New York City, last Saturday. The buildings destroyed abutted directly on the pressrooms of The Electrical Engineer, and obtained power from its shafting, and the fire necessitated an immediate shutting down, with the resort to such measures as were needed to prevent the spreading of the flames. Much time was lost on Saturday and Monday, therefore, through this catastrophe, but by special effort not more than an hour or two of delay has occurred in the issuance of the paper.

The Trip to Montreal.

It had been intended to make the N. E. L. A. trip to Montreal over the West Shore road, but at the last minute the West Shore officials find that they cannot furnish the facilities. The run will therefore be made over the New York Central, the special train leaving New York on Sunday morning, September 6, as already proposed. Mr. C. O. Baker will announce the details in a few days, so that every needed arrangement may be made.

A "C. & C." MOTOR DRIVING A DYNAMO.

It might at first sight appear paradoxical to install a motor to drive a dynamo for the purpose of generating current when the current itself is available in the first instance; but upon further consideration it will be apparent that where it is desirable to effect a change in pressure without reducing the same by means of dead resistances, or in other cases, the application of the motor-dynamo principle may effect considerable economy. This was found to be the case in the practice of the Edison Illuminating Company of Brooklyn, where a sub-station, placed at some distance from the main station, has its generators driven by a motor deriving the current from the main station. In an article[1] by Mr. W. S. Barstow, superintendent of the Edison Illuminating Company of Brooklyn, was demonstrated very clearly the saving that could be effected by this method and the reasons why it was adopted in place of installing engines at the sub-station.



C. & C. Motor Driving a Dynamo.

The plant, which is illustrated in the accompanying engraving, consists of a 50 h. p. C. & C. motor with a pulley at both ends of the armature, the motor being connected to the station bus. Two No. 6 Edison compound generators are connected to the motor, and the plant shows an average commercial efficiency of over 75 per cent., while the efficiency of the large station, by reason of the extra motor load, is increased over 10 per cent. The advantage of this arrangement can be better appreciated when, as pointed out by Mr. Barstow, on a station unit the loss of power due to engine friction and belting on an average load of 224.9 (at the engine) is 38½ h. p.; the low efficiency of the unit with a load of 50 h. p. can be easily appreciated.

The mission of this motor-dynamo plant is nothing more than to transform the bus pressure of the first district station to a variable pressure required at the station end of the large feeder in order to maintain a constant pressure at the standard sub-feeder extremity. The little motor-dynamo plant furnishes current from 2 A. M. to 6 P., M. and until the evening load was sufficient to be carried on a station unit the motor-dynamo plant was in operation 21 hours a day and 7 days per week.

1. See The Electrical Engineer, May 6, 1891.

THE PROPOSED UNDERROUND ELECTRIC RAILWAY IN PARIS.

A French engineer, M. Berlier, has asked the Paris Municipal Council to grant him a concession for the construction of an underground electric railway in that city, on lines similar to the City and South London Railway. The railway would consist of two tracks laid in one tunnel, and the length of the line would be eleven kilometres. The Works and Ways Commission recommends the council to include this scheme in its investigations concerning rapid transit in Paris.

A USEFUL FORMULA.

The following is a simple formula for determining the insulation resistance between a dynamo circuit and its frame :—

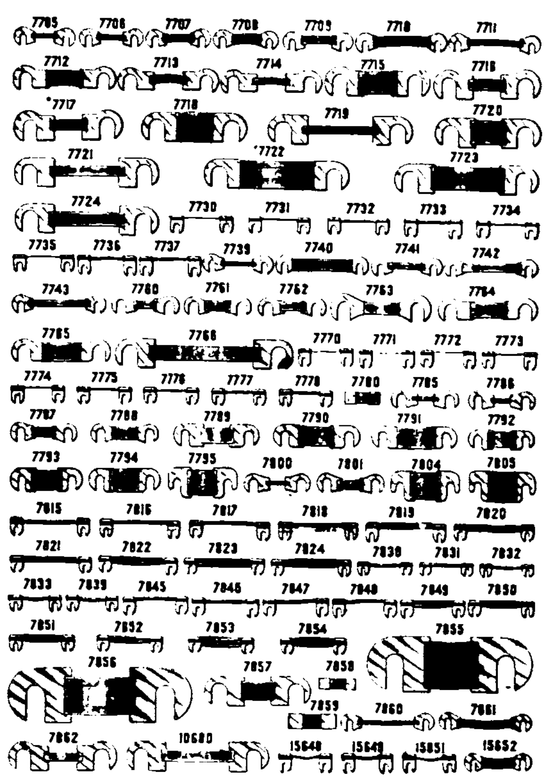
$$R = \frac{E - \varepsilon}{\varepsilon} \times r,$$

where R=insulation resistance in ohms, E=the terminal E. M. F. of the machine, ε=the sum of the volts observed between the positive brush and the frame, and between the negative brush and the frame, and r=the resistance of the voltmeter, which must be very high.

Mr. S. H. Southwick, for many years connected with the old Sprague Co. and the Thomson-Houston Co., has been appointed electrician of the Essex Electric Co., of Salem, Mass., and has begun work in that capacity.

THE FUSIBLE CUT-OUTS OF THE THOMSON-HOUSTON CO.

The simplicity of the fusible cut-out as a safety device in connection with electrical distributing circuits has made this type of protector the favorite one. It is true that the electromagnetic cut-out can be made to act with a greater delicacy, but the handiness of the metal fuse will probably make this the favorite one for some time to come. In order to give our readers an idea of the many details involved in the working out of a complete system of electric lighting and power distribution, we illustrate in the accompanying engraving the various sizes and types of fuses designed by the Thomson-Houston Electric Company for their varied work. These fuses are applied to circuits varying from 3 amperes up to 640 amperes, and designed for circuits varying from 50 up to 2,000 volts. The various types illustrated are designed in the shapes shown to accommodate the various types of generators, stationary motors, elevator motors, stationary motor cut-out boxes,



Thomson-Houston Fusible Cut-Outs.

railroad fuse boxes, and cut-outs in general. For feeder boards and boxes of the alternating type the fuses are covered with rubber so as to prevent accidental short-circuiting across them. Besides the fuses illustrated there are a large number of others intended for various purposes, which makes the aggregate number kept in stock amount to several hundred.

THE SANDY AND EASTER LEAKAGE DETECTOR.

An apparatus for detecting the leakage of electricity upon house or other mains has been lately brought out by Messrs. Sandy and Easter, of Peckham, England. The arrangement consists of a small board on which are three keys. The connections are so made that by pressing the centre key the potential between two terminals may be read off upon a voltmeter connected to them, and by pressing the centre and either the right or left hand key down together, the potential to earth on the positive or negative mains respectively may be read off on the voltmeter. Below the voltmeter terminals are two pins, for the purpose of holding a piece of pole-testing paper, so that if there be a leakage which is too small to be detected upon the voltmeter it will still be noticeable by the effect produced upon the paper, thus showing that the insulation resistance is low. The makers supply papers for detecting leakage upon circuits of 100 volts potential, where the insulation resistance is from 1 to 3 megohms, and these papers only change color when the insulation resistance is below the standard for which they are supplied. The makers state that with the apparatus they have succeeded in detecting the leakage in an experimental installation, having an insulation resistance of five megohms with an electromotive force of 100 volts.

OSBO-PREMIER PRIMARY BATTERY.

A battery has been designed under the above name for supplying light to small installations up to 30 lamps or so. The cell is of the single-fluid type, of carbon and zinc, and contains, in addition, a reoxidizing apparatus for reoxidizing the depolarizer, which becomes reduced in the course of working by the nascent hydrogen. Besides the outer vessel and the elements, the cell contains a porous tube with perforated bottom. This tube is tightly packed with the depolarizer, and only requires renewal every six to nine months. In the upper part of the porous pot is a glass tube (with side tube and glass stopper), the side tube going down into the depolarizer itself. When it is to be used, a reoxidizing bag is put in the tube with the addition of a little water, and the tube closed. A chemical action is thereby set up, which results in the liberation of oxygen, which flows through the tube into the depolarizer, hence reoxidising that which has been reduced.

The reoxidising bag consists of a special mixture of chloride of lime with a few crystals of nitrate of nickel; this, when acted upon by water or moisture, disengages oxygen, more especially if warmed. The battery solution provides for this, as in consequence of the chemical action it is always slightly above the temperature of the surrounding air. There is no action on open circuit with this solution, as the zincs are heavily amalgamated; nor is there smell or fumes. If it were not for the formation of zinc salts in the working of the cell, the same solution might be used indefinitely. The battery solution has to be changed, not because the depolarizer is exhausted, but because the solution becomes finally clogged with the zinc salts. Theoretically, the battery may be said to run by consumption of zinc and chloride of lime. The 12-cell battery is stated to run 30 hours, yielding a constant output of 14 amperes at 24 volts, and using 30 lbs. of zinc at $2\frac{1}{4}$d., $2\frac{1}{4}$ lbs. of depolarzier at 5d., and two dozen reoxidizing bags at $2\frac{1}{8}$d. per dozen. The cost is thus given as $14 \times 24 \times 30 =$ 10,080 watts, or 10 B. T. U. for a cost of 7s. The labor of changing is small. The battery seems an interesting departure, and we are informed that an installation will shortly be exhibited in London showing the battery in operation.

PRACTICAL ELECTRO-MAGNETIC UNITS.[1]

BY PROF. JOHN PERRY, F. R. S.

I would suggest that the practical unit of magnetic flux (or induction or force) be 10^8 C.-G.-S. units, and that it receive a name. That the magnetic permeability of air shall no longer be assumed to be unity, but, in the practical system of measurement, be tabulated like the permeability of any other substance; —the permeability of air will be $4\pi \times 10^{-9}$, and that in future no substance shall have unit permeability. That the unit of total magnetomotive force in a magnetic circuit be 1 ampere turn. The unit of magnetomotive force gradient would be 1 ampere turn per centimetre. It will follow that:

I. A wire one centimetre long, moving at 1 cm. per second across unit field, generates an E. M. F. of 1 volt.

II. If a wire 1 cm. long conveys 1 ampere, the power used

1. Abstract from the London *Electrician*.

(or developed) in moving it across the unit field at 1 cm. per second is 1 watt.

III. A magnetomotive gradient of one ampere turn per centimetre produces unit induction (magnetic flux or force) per square centimetre if the permeability is 1.

IV. Change of induction (magnetic flux or force) at the rate of one unit per second produces 1 volt per turn of wire.

If it were allowable to use 1 inch as the unit of length, and this would delight every electrical engineer in English-speaking countries, we can, by altering the above units, have all our rules quite simple, such as:

I. A wire 1 inch long, moving with the velocity of 1 inch per second across unit field (per square inch) generates the E. M. F. of 1 volt.

II. If a wire moving across unit field at 1 inch per second is conveying 1 ampere, the power used or developed per inch of its length is 1 watt.

III. The integral of the magnetomotive force all round any elementary solenoid in a magnetic circuit is exactly the number of ampere turns.

IV. Change of induction (magnetic flux) at the rate of one unit per second produces 1 volt per turn of wire.

ALTERNATE CURRENT MOTORS.[1]

BY E. HOSPITALIER.

ALTERNATE current electric distribution, in America at least, is comparable in size and extent with continuous current distribution, and they would be much more extensive if we knew how to conveniently utilize electric energy when distributed by means of alternate currents in connection with electro-chemical operation. It would increase the number of such plants, also, if we could store the energy supplied by alternate currents, and if we could easily transform alternate current electric energy into mechanical work; for such applications the continuous current motor has remained up to the present superior to the alternate current motor. The drawbacks that I have ennmerated are, however, compensated for by several advantages, viz., the simplicity of construction and cheapness of alternators, the easy production and transformation of the highest potentials (it being difficult to obtain more than 3,000 volts with continuous currents), simplicity and ease of insulation, simplicity and ease of transformation by means of inert apparatus, containing no moving parts, and having as high an efficiency as 95 per cent.

If the use of alternate currents for electro-chemical and storage purposes has scarcely yet been admitted (the partial solutions of the problem being still of an experimental character), the same cannot be said of alternate current motors. The various principles put forth, and the types based upon them, are already so numerous as to render necessary the summary classification given in the table below:

A.—CONSTANT FIELD OR SYNCHRONOUS MOTORS.

SEPARATELY EXCITED..	*Magnets.*—Magneto-Alternators.
	Electro-Magnets.—Dynamo-Alternators.
SELF-EXCITED.	"*Redressed*" *Current.*—Zipernowsky.

B.—ALTERNATE FIELD MOTORS.

Series-Wound Dynamo	Continuous current motor, with laminated field-magnets.
Shunt-Wound Dynamo	Continuous current motor, with laminated field-magnet.
Electro-dynamic Motors.......	Elihu Thomson meter.
Partially "Redressed" Field.	Mordey.
Closed-Circuit Armature......	Elihu Thomson.

C.—ROTARY FIELD MOTORS.

Ordinary or Single-Circuit Alternators.... ..		Ferraris.
		Tesla.
		Shallenberger.
		Hutin and Leblanc.
Multiple Phase Alternators.	*Three wires and two currents.*	Ferraris.
		Tesla.
		Borel.
	Three wires and three currents.	Dolivo-Dobrowolsky.
		Brown.
		Haselwander.
		Bradley.
		Wenström.

An alternate-current motor does not differ essentially in principle from a continuous-current motor. The same two essential parts are always to be found; the magnetic field, or inducing magnet, and an induced system rotating with reference to the other. While, however, the magnetic field of a continuous-current motor is always constant, that of an alternate-current motor is constant, alternating, or rotary, according to circumstaces.

Constant Field Motors.—This, the oldest type of motor experimented with, is based upon the principle of the reversibility of alternators. The alternate current is sent through the armature coils, which rotate in a constant magnetic field produced by a permanent magnet or by an electromagnet. The simplest is that formed by a Siemens double T coil revolving between the poles of a permanent magnet, or of an electromagnet excited from an external source. In this motor, if it has been brought up to the speed corresponding to the frequency of the alternate-current supplied (for example, 50 revolutions per second if the frequency of the alternator is 50), it revolves in synchronism with the alternator, following all its variations of speed unless a load of more than a certain amount is suddenly applied to it. If this is done the motor is thrown out of synchronism and immediately stops. The theory of these machines was developed in 1884 by Dr. Hopkinson. The necessity for synchronism at the start, and for an external source of electric energy for exciting the field magnet when large motors are wanted, and the necessity for running at a rigorously constant speed, have prevented these motors from receiving many commercial applications. Zipernowsky caused the two most serious of these inconveniences to disappear by rendering the motors self-exciting, the exciting current being derived from a shunt circuit containing a "redressing" commutator. A motor of this kind will start by itself when unloaded, and quickly attains its normal speed, which it keeps perfectly in spite of sudden variations of load. The efficiency of these motors is very satisfactory, attaining 80 per cent. in 4-kilowatt machines. In spite of—or, more exactly, owing to—the synchronism necessary for the running of these machines, a few of them have been used for the purpose of long-distance transmission of power.

Alternate Field Motors.—Any continuous-current dynamo supplied with alternate currents will start and continue revolving with considerable mechanical effort. A machine of this kind is comparable to an electro-dynamometer, the torque of which always remains the same in spite of the alternations in the direction of the current. A motor of this kind, however, possesses numerous and serious defects. The rapid alternations of current develop Foucault currents in the field-magnets, greatly reducing the efficiency of the motor, unless the precaution has been taken to laminate the cores. Moreover, the high inductance of the motor reduces the current, and consequently the output, of a motor of given dimensions. For these reasons motors of this type are but little employed except where small power is wanted, as in the case of motors driving small domestic ventilating fans, taking one to two amperes at a pressure of 50 volts, such as are in actual use in America. The exciting circuits of these motors are either arranged in shunt or series. If we suppress the iron in the field-magnets and in the armature, we obtain an electro-dynamic motor of small output, the motive couple of which is at any instant proportional to the currents traversing the armature and field coils. The energy meter of Prof. Elihu Thomson comes under the heading of an electro-dynamic motor. To avoid losses by Foucault currents and hysteresis due to the rapid reversals of magnetism of the field-magnets of motors of this type, Mordey has suggested passing the alternate current through a commutator on the shaft of the motor. On starting, the commutator has no effect, but as the speed increases the current becomes more and more "redressed;" that is to say, the losses caused by reversals of magnetism are reduced and the efficiency improved.

Closed-circuit motors also come under the head of motors with alternating fields. The electro-dynamic repulsion experiments of Professor Elihu Thomson have shown that a closed circuit placed in an alternating field tends to move so as to render the coefficient of mutual induction a minimum; in other words, it tends to reduce to a minimum the flux threading the coils. If we place a series of movable coils revolving round a common axis in an alternating field, and arrange the brushes so that each coil is successively short circuited at the moment when the flux threading it is a maximum, and open-circuited when the flux is zero, and so on, there will be exerted on each coil a certain torque, which, owing to the multiplicity of coils, will be sensibly constant. In motors of this type there is no connection between the field and the armature. The field coils are closed on the supply wires and the motor coils are closed on themselves. Such a motor can easily be realized by means of a small Gramme or Rechniewsky two-pole machine, if we take care to give the brushes a forward lead of about 45 deg. Alternate field motors are but little used, and no experiments as to their efficiency have as yet been published.

Rotary Field Motors.—Professor Ferraris, in March, 1888, was the first to make public the principle of these alternate current motors, the development of which now seems likely to cause a revolution both in long-distance transmission work and in the distribution of electric energy for small motors. The following is the principle established by Ferraris: When two alternate currents of the same period, lagging one behind the other by a quarter period, are passed through two circuits arranged at right angles, the result is a constant rotary magnetic field revolving at

1. Paper read before the Société Francaise de Physique.

a constant speed, making one complete revolution per period. If now a closed magnetic circuit is placed in this rotary field, it will be the seat of induced currents, and these induced currents will tend to turn the induced circuit in the same direction as the rotary field. With the exception of the method of producing the rotary field, the rotation thus obtained is identical with that of the classical "Arago" experiment, known under the name of "Magnetism of Rotation."

One might state with accuracy that the rotary field motor works in virtue of the Foucault currents, of which it is the seat. These Foucault currents would be zero if the circuit was stationary with regard to the field, that is to say, if the circuit revolved at the same speed as the field; and it is to fulfil this condition of relative immovability that the circuit turns within in the field, and in the same direction. In short, the circuit runs after the field.

Although of relatively recent invention, rotary field motors are already very numerous, and varied in principle and arrangement. They are distinguished amongst themselves chiefly by the mode of producing the rotary field, and by the generator which supplies current to the motor. I will now examine the ordinary alternate current motors, and the motors supplied with multiple phase currents.

There are several means of obtaining an ordinary alternate current, two alternate currents lagging a quarter phase behind each other, and capable, therefore, of producing a rotary field. Ferraris employed two circuits—one supplied with current direct from the alternator, the other connected to the secondary of a transformer, the primary of which was connected to the main leads of the alternator. Tesla employs two circuits arranged in shunt, and possessing widely different time-constants. Shallenberger employed a closed-circuit armature placed obliquely with reference to the primary circuit supplied with current from the alternator, and the reactions of the primary circuit and of the armature circuit producing a rotary field. In the Hutin and Leblanc motor the rotary field is produced by two sets of coils connected in parallel, a condenser being interposed in one of the circuits. In this way the quarter phase lag necessary for the production of a rotary field is easily obtained.

The above solutions of the problem are suitable in the case of distribution to comparatively small motors. For the purpose of long-distance transmission on a considerable scale, it is preferable to have recourse to special generators, no longer producing ordinary alternate currents, but several alternate currents lagging a fraction of a phase one behind the other, that is to say, "polyphasal" alternate currents. We may either employ two currents and four wires, or only three wires, using one as a common return. Devices of this kind have been brought out by Ferraris and Tesla. Being obliged to use three wires, some have preferred to employ three currents of equal periodicity, but lagging one behind the other one-third of a period. By taking advantage of the employment of three currents retarded in this way, we can make the algebraical sum of the currents at any instant zero, and one of the three wires can always serve as a return to the currents traversing the other two. Such is the principle of the motors supplied with "polyphasal" currents, devised less than two years ago by Dolivo-Dobrowolsky, Haselwander, Bradley and Wenström. A 300 h. p. transmission of power plant of this kind, due to Brown of Oerlikon, is now in process of erection between Frankfort and Lauffen.

This rapid enumeration of the methods actually employed or investigated for the convenient transformation of the energy of alternate currents for mechanical purposes shows that we may consider the problem as solved. It will doubtless be the same soon as regards the utilization of alternate currents for electro-chemical and storage purposes. Alternating currents will then assume a commercial importance superior to that of continuous currents, and we shall witness a new evolution of electric systems, while awaiting that which the employment of alternating currents of high frequency will some day give rise to.

ELECTRIC LIGHTING FIGURES IN CANADA.

THE council of an Ontario town recently sent inquiries to nearly all the cities and towns of Canada as to the yearly cost of each electric lamp in use for street lighting. The lights are paid for from 200 to 365 nights per year. The figures are: Montreal, $146; Toronto, $108.59; Hamilton, $102.10; Ottawa, $80; Halifax, $79; London, $94.05; Kingston, $65.80; St. Catherines, $77.10; Brantford, $105; St. Thomas, $102.20; Windsor, $80.30; Peterborough, $60; Stratford, $66; Belleville, $105; Woodstock, $56.50; Brockville, $101.50; Berlin, $60; Galt, $66; Cornwall, $17; Cobourg, $62.50; Truro, $85; Lindsay, $48; Barrie, $70; Yarmouth, N. S., $80; Ingersoll, $60; Bowmanville, $65.05; St. Marys, $39; Orangeville, $57; Paris, $58 50; Whitby, $45; Brampton, $64; Simcoe, $50; Kincardine, $52.80; Mount Forest, $75; Newmarket, $45; Wingham, $60; Palmerston, $45; Markham, $36. The figures are interesting, but are very incomplete. Many of these plants are run by water-power. Data is wanting also as to number of lights, length of lighting hours, and candle power of lamps.

ELEVENTH REUNION OF OLD TIMERS AND THE U. S. M. T. C., AT WASHINGTON.

THE annual meeting of these two societies began at the Ebbitt House, Washington, D. C., on August 19, at 10 a. m. The attendance was very large and unusually representative, due largely to the fact that it was the first gathering in Washington since the war, and that many of the members were busily engaged in the city in confidential and responsible positions during that great struggle.

About 100 were in the red parlor when President G. C. Maynard called the convention of Old Timers to order. He delivered an able and interesting address from the chair, reminding his auditors that Washington was a city filled with memories of Morse, Henry, Vail, Kendall, and others, whose labors brought the telegraph from a doubtful experiment to a practical success, as well as of the Ellsworths, the friends of Morse in his days of trial and waiting. But for the cheer given by Miss Ellsworth and her father to the great inventor, it was doubtful whether he would have secured help from Congress or carried his work through. From the very first, as it happened, women were associated with the telegraph, and on the old Erie and Michigan line, with 13 offices, not less than 6 women were employed.

Mr. Maynard made touching allusion to the recent dead, and dwelt on the attachment to the profession and the close feeling of union that telegraphers always manifested. He considered that telegraphers were still in the van of progress, the reason being that the telegraph was one of the best schools in educating men for practical business, and in affording high mental discipline.

A number of new members were then elected, showing a healthy state of growth, and Mr. W. J. Dealy, the secretary and treasurer, reported that there was a balance in hand of $355.

In the course of a few informal remarks Mr. Maynard then offered a few suggestions as to the work that lay before the association. He called attention to the fact that the effort to secure records of Old Timers by issuing circulars, in order to replace the documents destroyed in the Western Union fire, had already resulted in the accumulation of 500 reports, and they were coming in at such a rate that he expected to hear from at least 1,500 more. Those reporting had also suggested hundreds of names to be sent to, and he thought they would have 10,000 before they got through. It was an interesting fact to note that nine out of ten had begun in the business before they were fifteen years of age. Mr. Maynard also suggested that a plan should be adopted for securing the interchange of the portraits of all, and that the preservation of the relics of the early days of the art be given special attention.

A number of letters of regret at absence were read, including ones from Hon. J. D. Reid, Jesse Bunnell, Judge J. J. Wickham, George Kennan, the Siberian annalist; T. D. Lockwood, and D. H. Bates.

Mr. G. E. Gilliland handed in a check for $50 from Mr. J. R. McLean, of the *Cincinnati Enquirer*, as a contribution to the funds, in lieu of badges which he had intended to present to each member.

On motion of Mr. Plum, a historical committee was constituted, with Mr. G. C. Maynard as chairman, and it was also agreed that the present and past presidents of the two societies act together in this important matter.

Mr. Ives brought up the question of bringing down the year of admission a little later than 1869, so that Old Timers of a year or two later date might come in. This brought on an interesting discussion, and Mr. Dealy remarked that in 1894 the second twenty-five years would close, and then it would be time to think of the younger brood. On motion, however, of Mr. Talcott, a committee on revision of the constitution to deal with this point was voted for.

The meeting then adjourned till after the convention of the U. S. M. T. C.

The meeting of the U. S. M. T. C. was called to order at 3 p. m., by President W. R. Plum, of Chicago, who in a very eloquent address reviewed the history and work of the Corps, showing that it had numbered 1200 brave men, in the flower of youth, who had constructed 15,389 miles of military telegraphs during the war and sent 6,500,000 telegrams. This work was done amid all the perils of warfare, and many of the men had sacrificed their lives in the discharge of duty. Such was the success of the Corps, every civilized government had since established a system of the same kind, yet up to date no recognition of their services had been rendered them. Mr. Plum then went on to tell how the agitation for recognition had been kept up during the past four years, and urged its continuance on well-defined lines. "We solicit no pension," he said, "nor bounty, nor further compensation. Ours is not a raid upon the Federal Treasury, but an insistence upon a *de jure* recognition of a *de facto* status." He cited many eloquent testimonials from Grant, Sherman and others as to the value of their work, and insisted that they should be satisfied with no recognition short of an honorable discharge from the army, of which they had been a vital and integral portion. He concluded with the remark: "Here in the capital of a united and loyal nation let us again resolve, as we did last year at Kansas City, that a discharge from the army is a *sine qua non* to any acceptable certificate."

Secretary Pettit reported a balance in hand of $354, and stated how he proposed to deal with members in arrears.

The committee on Congressional action reported progress, covering the same ground as President Plum, and considered that the goal was nearer.

A motion was then adopted eulogistic of Gen. Sherman, and recognizing his appreciation of the work of the Corps. It was supported in a very eloquent and manly little speech by Mr. Ives.

The committe on place of meeting then reported Omaha, for the third Wednesday in August, 1892. Agreed to.

Mr. Dealy then cast the ballot of the meeting for Mr. W. R. Plum as president. Mr. W. B. Wilson was elected vice-president and Mr. Pettit, secretary and treasurer.

The Old Timers now reconvened, and Mr. Bliss nominated Mr. E. Rosewater, of Omaha, the editor and proprietor of the *Omaha Bee*, as president. This was unanimously carried. Mr. Dugan, of Tennessee, was elected vice president, and Mr. W. J. Dealy, secretary and treasurer. Messrs. P. J. Hutchinson, J. M. Turner, J. Q. Mason and W. B. Wilson were elected as the executive committee.

The convention then adjourned.

A very interesting display of mementoes and relics was made under the auspices of Mr. Maynard at the National Museum, where the permanent collection was supplemented by several special loan exhibits, among which were the Ellsworth and Morse portraits, loaned by THE ELECTRICAL ENGINEER; a number of Morse papers, books, etc., loaned by T. C. Martin; and a large collection of portraits, loaned by the *The Telegraph Age*. The whole was inspected with very great interest by the delegates and their friends.

The issue of THE ELECTRICAL ENGINEER of August 19, containing as it did so much of interest to both the Old Timers and the U. S. Military Telegraph Corps, was in great demand and was very eagerly read by all the delegates, many of whom had been participants in the scenes illustrated and described.

The whole of Wednesday was devoted by the Old Timers to junketing of a most delightful nature. The White House, Corcoran Gallery, National Museum, Capitol and other places of interest were visited, and a group photograph was taken on the steps of the Treasury. From the fact that so many telegraphers, old and new, are employed in positions of responsibility in the various departments, it was easy enough to obtain access everywhere.

On Wednesday evening a reunion was held in the armory of the National Rifles, under the auspices of the local committee. Congratulatory dispatches were received in the hall from all over the country, and one came from the City of Mexico. Several speeches were made, notably by President Maynard, Mr. W. W. Burhans, of the United Press; Assistant Secretary Nettleton, of the Treasury; Col. Whitfield, of the Post Office Department; Assistant Secretary Willits, and Assistant Secretary of War Grant. A letter was also read from Hon. James D. Reid. Prof. Watkins, of the Smithsonian, urged the collection of relics of the early days of the art. Then came a choice collation, accompanied and followed by music.

On Friday the party made an excursion to Mt. Vernon, the home of Washington, and despite the bad weather, greatly enjoyed the inspection of the old mansion and the many relics it contains. Most of the delegates returned home the same evening. The fact that not a few of them were accompanied by their wives and daughters made the whole convention one of the brightest in its social aspects that the two societies have ever had.

Great praise is due to the local committee for its work, especially Messrs. M. W. Barr, the chairman; G. C. Maynard, Fred. Royce, M. Marean, W. H. Young, A. B. Talcott, H. G. Safford. Every attention possible was shown to the delegates, and in addition to the general programme there was a large amount of private entertainment.

"EARLY PRESENTATION OF THE BEST NEWS."

MR. E. H. CROSBY, of the *Boston Post*, says: "I am a constant reader of your valued paper and I am pleased to add my testimony to that of many others as to its accurate and reliable electric information. Its news is of the latest and most authentic, and it stands far in advance of all similar publications in regard to the early presentation of the best news. I would not be without it for twice the subscription price."

MR. C. M. PARKER, the electrical engineer of the Metropolitan Electric Railway Co., of Springfield, Mo., has resigned to accept a similar position in St. Louis.

MECHANICAL TABULATION OF CENSUS STATISTICS.[1]

DR. BILLINGS said that the data collected by the census for each living person, or in systems of death registration for each decedent, might be recorded on a single card or slip by punching small holes in different parts of it, and that these cards might then be assorted and counted by mechanical means according to any selected grouping of these perforations, as was first suggested by him in 1880. This suggestion was taken up by Mr. Herman Hollerith and by him has been elaborated into practical shape the system which is now in use in the population and vital statistics division of the eleventh U. S. census, and which has been adopted for the compilation work of the recent Austrian and Canadian censuses.

For each individual living in the United States June 1, 1890, as shown by the census schedules, the facts relating to sex, age, color, conjugal condition, birthplace, birthplace of each parent, occupation, number of children, etc., have been indicated on a piece of stout manilla paper 6⅝ inches long by 3¼ inches wide, by punching holes in different parts of it. For each decedent during the census year the same facts are reported, and, in addition, the cause of death and the month of death. The place of residence, by State and district, is indicated in like manner.

The number of subdivisions which can be distinguished in recording the different classes of facts in this way is very great. For example, in forty-eight spaces it is possible to record the distinction for each of 45,000 different districts, as is actually done by the gang-punch system for the census.

The cards thus punched are passed through machines in which an electrical connection is made by the passage of a metal rod through the cards wherever a hole has been punched, and the currents thus produced actuate a series of small dials on which the number of the data is recorded. About forty of these dials are usually used at once, each of which records a single class of facts. For example, the first dial may be set to count males under one year of age, or all white males under one year of age, or all white males born in Pennsylvania under twenty years of age, or all white male butchers in Pennsylvania whose mothers were born in Germany and who are between twenty-five and thirty years of age. If no record has been punched on the card for age, birthplace, etc., the machine does not record, and the attention of the operator is called to the fact that the card is defective.

The machine not only records certain groups of facts on the dials, but has a series of assorting boxes which also have electrical connections by means of which the cards, as they pass through the machine, can be assorted into groups on any system required; as, for instance, into groups of ages, into groups of birthplace, or according to birthplace of mothers, or according to occupations, etc.

In the population division, after a little training, the average number of cards punched per day by each operator was 766, some punching 1,200 to 1,400 per day. In punching death records the work was a little slower, but ten clerks averaged over 1,000 per day each.

The accuracy of the work in punching by each person was tested at the beginning in what was called practice work, and no one was allowed to enter upon the work of punching until the percentage of error made in practice work had been reduced to the minimum. A certain proportion of cards punched by the clerk in his particular section was each day carefully compared and verified, and the number and character of errors made recorded and reported.

The number of cards which can be passed through the machine in a day's work of seven hours depends on the number of readings which have to be taken from the dials, which, of course, depends upon the size of the unit of area for which the reading is taken. At the commencement the daily average number of cards passed through the machine for each worker, with an average of five readings copied off, was 8,404. At the end of July the average number for each worker, with an average number of nine daily readings, was 7,000. Taking the ten most expert operators in July, the daily averages were 7,879, 8,723, 9,008 and 9,368. In the vital statistics divisions the highest daily average for four months are as follows: January, 12,404, with sixteen readings; February, 11,912, with thirteen readings; March, 12,021, with nineteen readings; April, 12,665, with eighteen readings.

With these figures may be compared those for transcribing census data on cards and compiling by assorting these cards, as was done in preparing the statistics of the insane, deaf and blind. The average number of individual records copied in script per day per clerk was 164. For the last week it was 252. These records contain all the data on the population schedule and also the special data of the class. In assorting these cards about 1,750 per day would be distributed by one clerk and the readings taken.

The conclusion is that the data on population schedules and schedules of deaths can be copied from 25 to 50 per cent. more rapidly by punching than by transcribing, and that, with punched

1. Abstract of a paper read by Dr. John S. Billings before the Economic Science and Statistics Section, A. A. A. S., at Washington.

cards and the electric counting machine, the usual tables can be compiled from four to eight times more rapidly than by assorting the written cards. The relative accuracy of the results of the two methods is about the same.

The saving in time and clerical labor effected by the use of punched cards and the electric counting and assorting machine depends on the number and complexity of the different tables compiled and on the number of individual records. For the work of the eleventh census the saving thus effected is estimated as being at least half a million of dollars.

FUNCTIONS AND NATURE OF ETHER IN SPACE.

In the admirable address delivered by Prof. F. E. Nipher, before the Physics Section of the American Association for the Advancement of Science, at Washington, he took up the various phases through which the study of the ether had passed, and remarked that in former days many reasons given for the existence of the ether do not seem conclusive now. We could hardly subscribe to the sentiment that there must be an ether or nature would be disgusted with the greater portions of space and the planets and stars would fall to the ground.

We have other needs for an ether, which to us seem important and pressing; still we may perhaps wonder occasionally, with Theophratus Such, what kind of hornpipe we are dancing now.

For 25 years it was taught that light was an elastic pulsation in an uncompressible jelly-like medium. Some of the mathmetical deductions of Green he could only reconcile with the observed phenomena by making the ether incompressible.

In 1865 Maxwell proposed his theory that light was an electric displacement in a plane at right angles to the line of propagation. Maxwell's theory met with great favor. It afforded simple and natural explanations for phenomena which had previouly been clouded by rather strained assumptions.

Twenty-three years later, in 1888, Sir William Thomson brought a powerful reinforcement to the elastic theory. He showed, as did Green, that the compression wave, which theory called for and which did not exist in fact, might be got rid of in the theory by making the volocity of the compression wave zero instead of infinite. Thomson found what had escaped Green, that this assumption did not involve an unstable condition of the medium, and that, therefore, it was admissible. It was also shown at once by Thomson, Willard Gibbs, and Fitzgerald that this new and rather startling suggestion placed the elastic and electric theories on the same logical basis if the ether was considered incompressible in the electric theory, and to have a rigidity zero for a compression wave in the elastic theory. It is, in fact, worthy of remark, as a matter of congratulation, showing how far scientific men have emerged from the intellectual pugilism of the last century, that Thomson's audacious departure was met with pleased surprise instead of with angry polemics against a new heresy.

The showing up of light in space occupied by matter shows that the ether within must either be more dense (as Fresnel believed) or less elastic than that existing in free space. It is certainly very difficult to understand what there can be in the molecules of matter which can increase the density of an incompressible medium. The beautiful experiment of Michelson and Morley shows apparently that the ether at the surface of the earth moves with it. It is dragged along as if it were a rigid liquid. The field of a steel magnet is, however, a rotational phenomenon. It is a spin which is maintained permanently without the expenditure of energy. It seems, therefore, that the resistance to shear which shows itself in the adhesion of the ether to the moving earth must be a rigidity due in some way to motion. Other experiments of Michelson and Morley on the motion of light in moving columns of water have been taken as proof that the ether in water is condensed to nine-sixteenths of its volume in air. The ether in water certainly behaves as if it were more dense, but it is another matter to say that it is so. It seems improbable. It is still a mathmetical fiction which covers a gap in our knowledge of the ether. The speaker thought that the experiment should be repeated with water at rest within a tube which should be mounted on elastic supports in a moving railway car. The water tube and observer's seat should be rigidly connected and swung on dampened spring supports from the top and sides of the car. The question to be settled is whether the ether, or any part of it, is at rest in space, and does it sweep through the interior of bodies which move through it as wind sweeps through the leaves and branches of a tree. This form of the experiment is the one contemplated by Eisenlohr's analysis leading to Fresnel's formula, and it is capable of great variations in the conditions of experiment. It is, however, more difficult and more expensive than the one so well executed by Michelson and Morley. Whatever its results may be, it promises to add greatly to our knowledge of the physics of the ether.

Gen. C. H. Barney, late of the "A. B. C." Company, has been apppointed by President Huntley as officer in charge of the exhibition at the coming Montreal Convention.

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed Editor of The Electrical Engineer, *150 Broadway, New York city.*

DROP IN POTENTIAL ON UNDERGROUND FEEDERS.

The last sentence in your very interesting article on the Insulation Resistance of the Street Railway Mains in the City of Minneapolis, Minn. (The Electrical Engineer, August 19, page 224), reads as follows: "The drop in the potential at the terminals of the feeders employed in the conduit is 5 per cent., while in the other systems, where the overhead feeders are used, 10 per cent., and over, is the result."

Of course, to an engineer, the meaning is plain enough. Lest, however, some beginner be led into error, it may be well to point out that the mere insertion of the feeders into a conduit system cannot be relied upon to save 5 per cent. potential loss more than would occur were the same wire strung overhead, this last being the natural inference from the statement quoted.

The number of volts lost in the conductors being, of course, in both cases a question only of cross-sectional area (circular millage) disregarding special cases involving the condenser effects of electrostatic capacity.

J. Stanford Brown.

New York City.

Society and Club Notes.

SOME OF THE EXHIBITORS AT MONTREAL.

We give below a partial list of the firms and individuals to exhibit at Montreal:

Eureka Tempered Copper Co., North East, Pa.; Charles A. Schieren & Co., New York; Standard Underground Cable Co., Pittsburgh, Pa.; W. J Johnston Co., Limited, New York; Standard Electrical Time Co., New Haven, Conn.; Standard Paint Co., New York; Fort Wayne Electric Co., Ft. Wayne, Ind.; Electrical Engineering & Supply Co., Syracuse, N. Y.; Eugene F. Phillips Electrical Works, Limited, Montreal, Can.; Felten & Guilleaume, Cöln, Germany; International Okonite Co., New York; Weston Electrical Instrument Co., Newark, N. J.; The Johns-Pratt Co., Hartford, Conn.; The Ball Electric Light Co., Toronto, Can.; The Electrical Engineer, New York; Interior Conduit & Insulation Co., New York; Robert Mitchell & Co., Montreal, Can.; Thomson-Houston International Electric Co., Boston, Mass.; Toronto Construction & Electrical Supply Co., Toronto, Can.; H. Ward Leonard, New York; Dominion Wire Manufacturing Co., Montreal, Can.; T. W. Ness, Montreal, Can.; Edison General Electric Co., New York; Norwich Insulated Wire Co., New York; Excelsior Electric Co., Boston, Mass.; Canadian Electrical Construction, Manufacturing & Supply Co., Montreal, Can.; Russell Electric Co., Boston, Mass.; *Electric Power*, New York; McGill University, Montreal, Can.; La Boiteaux Electric Motor & Fan Co, Cincinnati, O.

Obituary.

Mr. John C. Folger, an attaché of Mr. Frank Ridlon's office, and well known to many in Boston as an enthusiastic electrician, died suddenly recently. Newspaper reports had it that he died from an electric shock, but upon inquiry it was found that the electric shock was sustained two weeks previous to his death, and that he had been carried off by typhoid fever. Mr. Folger was a young man of 18, and was well esteemed by all who knew him as a bright, energetic and promising electrician.

The Insulated Wire Department of the National India Rubber Co., of Bristol, R. I., is now in full operation, and, under the direction of Mr. Frederick S. Minott, is furnishing rubber line wire and lead-covered underground cables for any desired voltage.

This company, having had 25 years' experience in the manipulation of india-rubber, is peculiarly well fitted to produce a reliable compound, and the use of the best materials together with the employment of careful workmen and expert electricians will undoubtedly insure its success. The new catalogue and price list issued by the company gives full information regarding its various products.

TRADE NOTES AND NOVELTIES

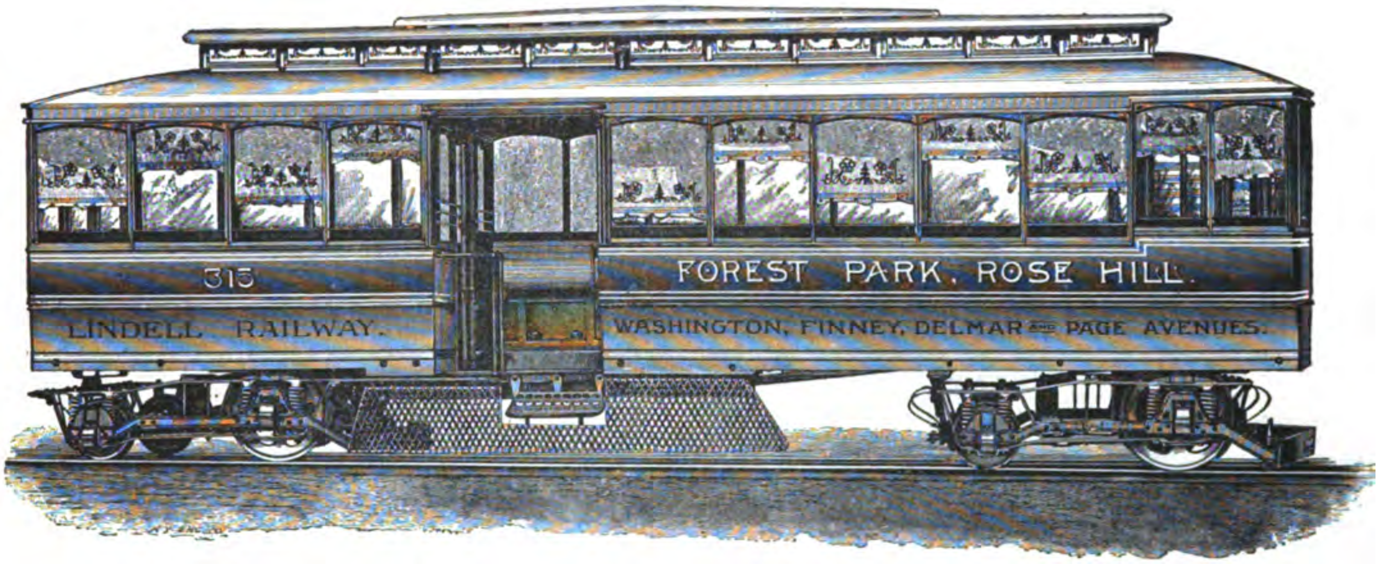
AND MECHANICAL DEPARTMENT.

A liberal advertiser has good crops every year.

A NEW DEPARTURE IN ELECTRIC AND CABLE CARS.

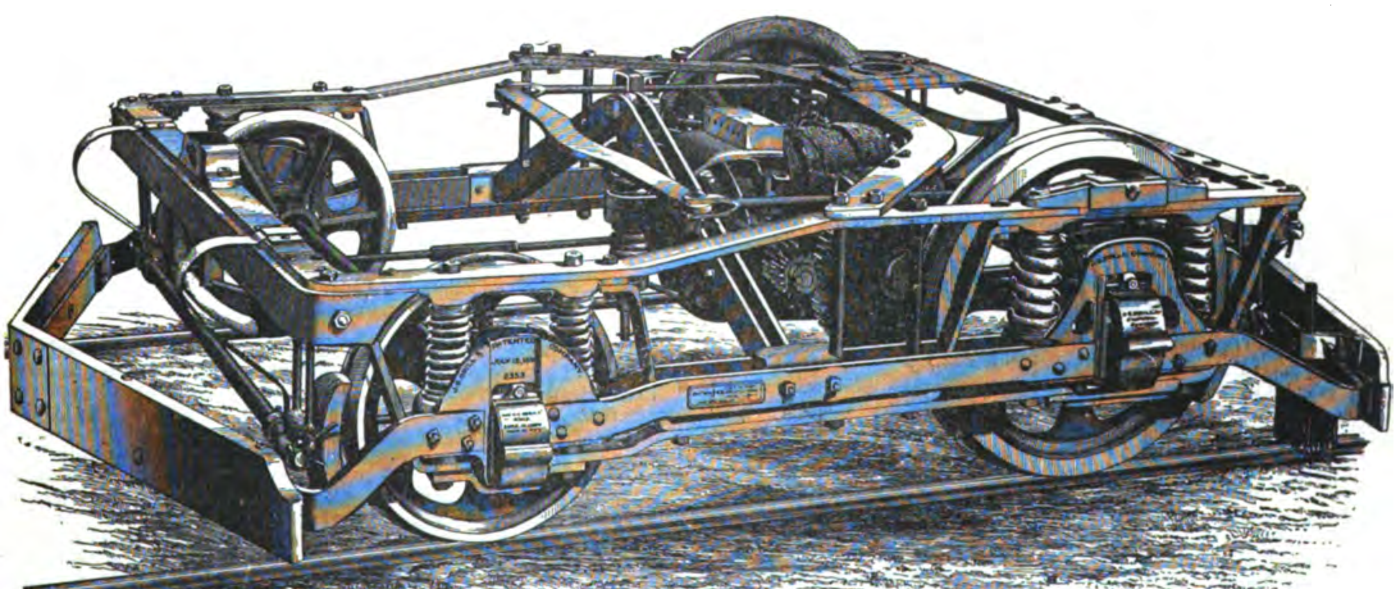
A GROWING tendency to the use of longer cars where the motive power is other than animal power has developed the fact that but very little can be added to the length of a car of the ordinary type without considerable sacrifice of the time taken to load and unload passengers, and an increased difficulty in collecting fares on long cars having a platform at each end. The adoption of electricity and cables as motive powers, and the consequently quicker transit, has increased in a wonderful degree the number of passengers carried, and the railroad companies naturally seek to add to their carrying capacity in the most economical manner. To increase the seating capacity in a car without adding to the length occupied on the street by the present horse car, and to attend to the passengers and collect the fares by the employment of one man as conductor, are the two directions by which this economy is reached.

In a new car just completed for the Lindell Railway Co., of St. Louis, by J. G. Brill Company, the economical features above referred to are accomplished. This car is the invention of Mr. Jno. A. Brill, vice-president of the J. G. Brill Company, and the novel features embraced in it are covered by three patents. The most evident novelty is that the car has no end platforms, but has a vestibule or platform enclosed on three sides near the centre of the car, which is open only on one side of the car, and connects with the two compartments by door-ways. The front platform of an ordinary car has no use except for the motorman, carrying no passengers, and in this car the whole of one platform with its unnecessary length and weight is dispensed with.



THE NEW BRILL CAR.

The car is divided into two compartments separate from each other; the forward compartment is for the usual mixed passengers and the rear compartment is intended primarily for the use of smokers, the larger being 17½ feet long and the smaller 10½ feet long. The seats in this car are placed transversely, with capacity for two persons on a seat, on each side of the aisle, and there is a seat on the closed side of the vestibule for three persons. At one end of the single step there is a convenient space guarded by a stout hand rail of polished brass for the conductor to stand in, from which point he has complete control of the car, and can easily reach passengers who require his assistance in getting on or



THE NEW BRILL TRUCK.

off the car. The seats in the car can be arranged if preferred in the usual manner of street cars, that is, longitudinally on the sides. The total seating capacity of the car is 46 persons.

With this arrangement of the entrance near the middle of the car it is evident that the passengers will not require so long a time to get to or from their seats as they would in cases where the entrance is placed at one end, and for the same reason the conductor can reach both ends of the car for collecting the fares with greater facility; and having this advantage, one man can collect all the fares and attend to all the passengers. An ordinary horse car is 23 feet long, and, with the horses attached, occupies 35 feet in the street, seats 22 persons and requires one conductor. The new style of car is only 31 feet 6 inches, extreme length, and seats 46 persons, and can be worked with equal ease by one conductor. As it carries as many passengers as two ordinary horse cars, there is a saving of one conductor for a given number of passengers. The saving in wages alone on a line using 100 cars is from $200 to $250 per day, representing an annual saving of over $70,000, an amount sufficient alone to pay a dividend greatly in excess of the average dividend on street railroads.

In cities with crowded streets like New York, Philadelphia, Chicago, the saving of one-half the street space of cars is an item of enormous advantage; and this car is only 7½ feet longer than the adopted size of motor cars with vestibuled ends, which seats only 22 persons.

The motorman stands in a place four feet long and two and a quarter feet wide, well sheltered, but with complete view of the track. This space is partitioned off with mahogany panels and plate glass sash, by which he is freed from all crowding and interference by passengers. Another important advantage which this long car has over a train of motor car and "trailer" is the superior control in stopping the car by which the train cannot be made to act as promptly as desired unless by use of the automatic brake, which is effective, but costs $300.

The Lindell Railway Company, with its characteristic enterprise and desire to give its patrons the very best that can be had, has ordered this car to be finished in the most elegant manner, with solid mahogany, polished plate glass, embroidered linen shades, polished brass mountings, and seats where a passenger will not have to struggle for the 17 inches usually alloted to him. The successful working of this long car with electric motors is dependent, however, on the use of Brill's patented "Maximum Traction Trucks," on which more than 90 per cent. of the traction is upon the two pairs of driving-wheels of the trucks; and the peculiar form of the truck entering the bottom frame of the car body sets the car so low that it required only a single step of the usual height at the entrance. The use of this style of truck on the Newark passenger railway has made a great success of the operating of long cars at a time when the company was on the point of abandoning their use as being a failure, by reason of the deficient traction and excessive height of the car body, which caused two steps to be necessary.

THE LIEB OVERHEAD WIRE CONSTRUCTION.

THE accompanying illustrations show two forms of construction employed by the Lieb Machine Works, of this city, in overhead electric railway work.

In Fig. 1 is seen the method used in city lines. Here the Lieb insulated turn-buckle not only plays the part of a perfect insulator of great length and strength, but it also entirely obviates the necessity of a pole ratchet. All the slack necessary can be taken up with the turn-buckles, and the span-wire, being insulated from the trolley by the insulated hanger and from the poles by the insulated turn-buckle, a double insulation is thus secured. This insulated turn-buckle, like the wooden insulator, can be used in various ways to make combination appliances for line work.

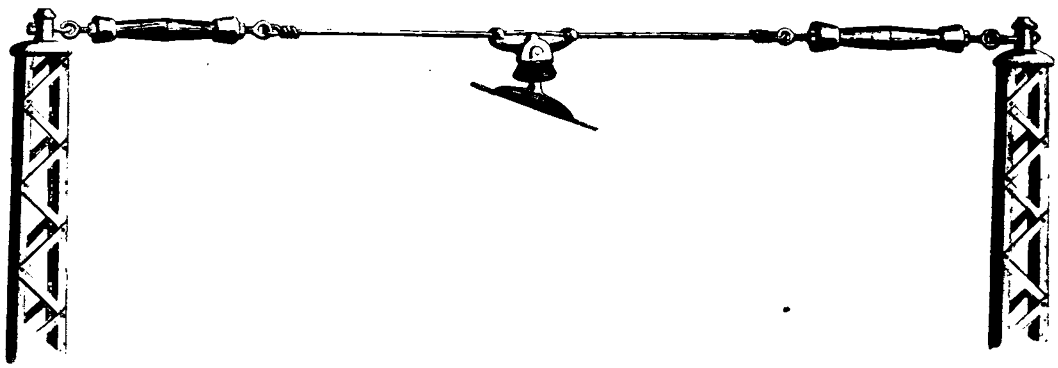


FIG. 1.—OVERHEAD CITY CONSTRUCTION.

Fig. 2 shows one of the many ways in which the Lieb wooden insulators can be applied in line construction. In this case the trolley-wire bell usually employed is entirely dispensed with, and a metal piece substituted for it. The first cost is thus greatly reduced. The outer ends of the span-wire are thoroughly insulated, the small section only between the wooden insulators being alive.

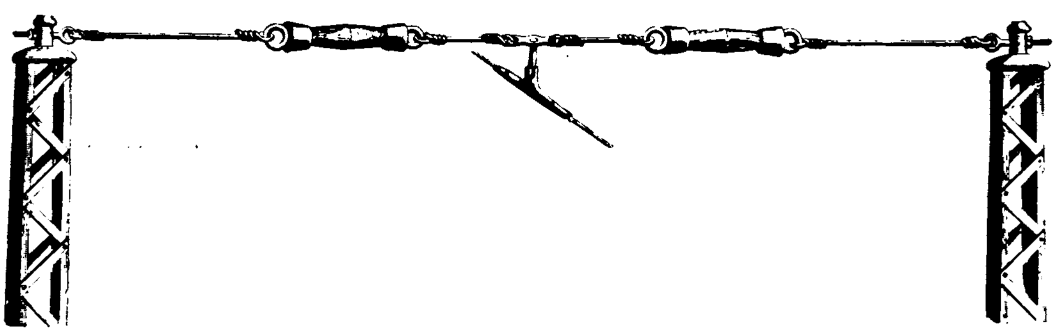


FIG. 2.—OVERHEAD SUBURBAN CONSTRUCTION.

For suburban work, where there are few telegraph wires, this construction has been found wholly satisfactory.

H. WARD LEONARD & CO.

WITH regard to the above new concern, it may be stated that H. Ward Leonard & Co. is a corporation organized under the laws of the State of New Jersey. Its present authorized capital is $200,000. The original subscription was for $50,000. $32,000 of which was subscribed by the incorporators. The revenues of the company will be of a character such that comparatively little capital will be required considering the net revenue. The shares of the company are $100.00 each. The present stockholders include some of the most prominent of the various leading electrical companies. None of the stock of the company is issued for anything but absolute cash or its equivalent, and every shareholder is on exactly the same terms as every other shareholder. That is, there will be no issuing of stock for contracts, patents, franchises or similar considerations having an indefinite value.

The company is already preparing actively for business, and is getting its offices in the Electrical Exchange into order, so as to take up the work that has already begun to flow in.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

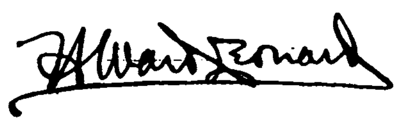
THE

Electrical Engineer.

VOL. XII. SEPTEMBER 2, 1891. No. 174.

MINIMUM FIRST COST OF PLANT AND MAXIMUM ECONOMY OF OPERATION IN THE ELECTRICAL TRANSMISSION OF POWER.

BY



A GREAT deal has been, and is being, written and said about the condition governing the minimum first cost of a plant for the transmisson of power by electricity, and also about the conditions governing the maximum economy of operation of such a plant, and some radical errors and false deductions have been made by those who are considered authorities upon this subject, so that it is not surprising that a somewhat erroneous idea at present exists in the mind of the electrical public upon this question.

As a rule, the theories and deductions developed by the various papers on this subject have given as a conclusion certain formulæ and laws, the application of which is practically impossible because of the necessity of using factors, the determination of the value of which is fully as great, if not greater, a problem than that, the solution of which is attempted. The result of this has been that vital errors in some of the most noteworthy papers on the subject have remained unnoticed by most readers, and even if others besides the writer have been familiar with these errors, they have probably felt, as he did, that no good purpose would be served by calling attention to them, as no practical application seemed to have been attempted of these formulæ or laws.

The recent publication, however, of a compilation entitled "Electric Transmission Hand-Book," by F. B. Badt, makes it appear of importance to call attention to the serious errors contained therein, for Mr. Badt not only publishes all the original errors of the authorities he quotes, but he proceeds to carry the erroneous deductions further and to give and solve practical problems in a manner such that the reader cannot but receive a clear and definite, although entirely incorrect, understanding of the subject. Furthermore, some of the formulæ published by Mr. Badt, and for which the present writer is responsible, have been interpreted by means of erroneous laws laid down by Mr. F. J. Sprague, and consequently an entirely false meaning has been given to formulæ which, when properly interpreted, are entirely correct. In order to point out the errors mentioned in as clear a manner as possible, I shall first treat the subject generally and deduce the correct laws, and then point out the inconsistencies and inaccuracies of the conclusions, formulæ and laws given by Mr. Sprague and Mr. Badt.

Under date of August 16, 1886, the writer published a general formulæ for the determination of the size of conductors which should supply devices arranged in multiple arc, the form of which was as follows:

$$M = \frac{\text{K. W.} \times D \times 21{,}400}{V(E-V)}; \qquad (1)$$

in which M = Circular millage of conductor.
K. W. = Kilo-watts at terminals of translating device.
D = Distance of transmission in feet.
E = E. M. F. at generator brushes.
V = Volts lost in transmission.

For the sake of explicitness I will indicate the derivation of the formulæ.

Res. of 1 foot-cir. mil of commercial copper = 10.7 ohms.
Res. of 2 D feet of conductor of 1 cir. mil = 21.4 D.
Res. of 2 D feet of conductor of M cir. mil $= \frac{21.4\ D}{M}$.

$$M = \frac{21.4\ D}{R}. \quad \text{Now } R = \frac{V}{C} = \frac{V}{\frac{1{,}000\ \text{K.W.}}{E-V}} = \frac{V(E-V)}{1{,}000\ \text{K. W.}}$$

$$\therefore M = \frac{21.4\ D \times 1{,}000\ \text{K. W.}}{V(E-V)} = \frac{\text{K. W.} \times D \times 21{,}400}{V(E-V)}. \qquad (1)$$

Weight of 1 foot cir. mil of copper = .000003027 lb.

∴ Calling T the weight of conductor in lbs. and allowing 3 per cent. for sag, etc.

$$T = \frac{D^2 \times \text{K. W.}}{V(E-V) \times 7.5} \qquad (2)$$

Calling B the cost of conductor in dollars, we have, with copper at L cents per lb.

$$B = \frac{D^2 \times \text{K. W.} \times L}{750\ V(E-V)}. \qquad (3)$$

∴ The cost of the conductor per K. W. at motor brushes is

$$\frac{B}{\text{K. W.}} = \frac{D^2\ L}{750\ V(E-V)}. \qquad (4)$$

Calling G, the cost of dynamo electric machinery per K. W. at brushes, and $\frac{A}{\text{K. W.}}$, the cost of generator per K. W. at motor brushes, we have

$$\frac{A}{\text{K. W.}} = \frac{100\ G}{100-P}, \qquad (5)$$

where P = the percentage of loss in the conductor; this may also be expressed as follows:—

Cost of generator per K. W. at motor brushes,

$$\frac{A}{\text{K. W.}} = \frac{G\ E}{E-V} \qquad (6)$$

The cost of the generator and of the bare copper for the conductor are the only two elements of the cost of a power transmission plant which it is necessary to consider in the determination of the condition of Minimum First Cost of Plant, for the other factors of the cost of the plant, such as the development of the motive power, the labor of erecting the line, etc., are not proportionate to the power delivered, and hence should not be considered in the determination of the minimum conditions.

With any given initial E. M. F. and distance, it is evident that the more volts we lose in the transmission, the less will be the cost of the conductor; but at the same time the cost of the generator per unit of power transmitted will be increased because of the additional generator capacity required to take care of the increased amount of energy lost in the conductors.

Hence it is evident that for any given initial E. M. F. and distance there must be some particular loss in the conductor which will make the combined cost of the generator and conductor a minimum. We can determine the minimum value by placing the first differential of the expression indicating the sum of the costs of the generator and the conductor, equal to zero.

From (4) and (6) we have, cost of generator plus cost of conductor

$$= \frac{A+B}{\text{K. W.}} = \frac{G\,E}{E-V} + \frac{D^2\,L}{750\,V(E-V)} \quad (7)$$

Placing the first differential $= 0$ we have:

$$\frac{G\,E}{(E-V)^2} - \frac{750\,D^2\,L\,(E-2\,V)}{750^2\,V^2\,(E-V)} = 0. \quad (8)$$

From which we get, $D^2 = \dfrac{750\,G\,E\,V^2}{L\,(E-2\,V)}$. (9)

This last equation expresses the relation existing under the conditions of Minimum First Cost of generator and conductor, and consequently of the entire plant.

Since $\dfrac{E}{(E-2\,V)} = \dfrac{100}{100-2\,P}$, (10)

we have from (9) and (10)

$$D^2 = \frac{75{,}000\,G\,V^2}{L\,(100-2\,P)}. \quad (11)$$

Calling $\dfrac{B_M}{\text{K. W.}}$, the cost of conductor in dollars per K. W. at motor brushes under condition of minimum first cost of plant, we have from (4) and (11)

$$\frac{B_M}{\text{K. W.}} = \frac{G\,E\,V}{(E-V)\,(E-2\,V)} \quad (12)$$

$$\text{and} = \frac{100\,G\,P}{(100-P)\,(100-2\,P)} \quad (13)$$

Calling $\dfrac{A_M}{\text{K. W.}}$ the cost of generator in dollars per K. W. at motor brushes under conditions of minimum first cost of plant, we have from (6) and (9)

$$\frac{A_M}{\text{K. W.}} = \frac{D^2\,L\,(E-2\,V)}{750\,V^2\,(E-V)} \text{ and} \quad (14)$$

$$= \frac{D^2\,L\,(100-2\,P)}{750\,V^2\,(100-P)}. \quad (15)$$

When the cost of dynamo is \$33 per K. W. at brushes and copper is 20 cents per lb., that is, when $G = 33$ and $L = 20$, we have, from (11),

$$D^2 = \frac{123{,}750\,V^2}{100-2\,P} \quad (16)$$

From (3) we have $D^2 = \dfrac{\dfrac{B_M}{\text{K.W.}} \times 750\,V\,(E-V)}{L}$. (17)

With any fixed initial E. M. F. and a certain percentage of loss, we can get by (13) the value of $\dfrac{B_M}{\text{K.W.}}$, the cost of the conductor under conditions of minimum cost; and knowing the cost of the conductor, we can by (17) get the value of D. Thus for any initial voltage and percentage of loss we can determine the cost of conductor and the distance of transmission which corresponds to the minimum first cost of plant. By determining such values at 10, 12½, 15, 20, 25, 30 and 40 per cent., we are able to plot the lines of minimum first cost as given by the accompanying CHART I.

By the use of CHART I we can quickly determine the percentage of loss necessary for any initial E. M. F. and distance, in order that the cost of plant shall be a minimum; and we also learn at the same time the corresponding cost of the generator and of the conductor.

Thus, if we have an initial E. M. F. of 3,000 volts and a distance of 50,000 feet we must, in order to secure the minimum first cost of plant, operate with a loss of 30 per cent., and in such case the cost of generator = \$47.15, and cost of conductor = \$35.35 per K. W. at motor brushes; so that, adding the cost of motor, \$33 per K. W., we have, total cost of generator, conductor and motor = \$115.50. (*Example* 1.)

Similarly if we have a distance of 30,000 feet and 3,800 volts initial E. M. F. we must operate at 20 per cent. loss, and the total cost of generator, conductor and motor will be \$88.00. (*Example* 2.)

Now, it by no means follows, because we are working with the minimum first cost of plant for a certain voltage and distance, that we are working at the highest economy, for, evidently, it is possible that if we work with a less percentage of loss in the case cited in Example 1, although our investment be increased thereby, the interest and depreciation on this increase of investment may be much less than the saving we would effect, due to the reduction of the loss of energy in the conductors. In other words, we must consider the variation in the interest and depreciation upon the investment, as well as the variation in the value of the energy wasted in the conductors, and must make the sum of the interest and depreciation on investment plus the value of the energy wasted in the conductor, a minimum, in order to operate at the maximum economy.

The interest on the investment can be definitely determined, but the value of the energy wasted it is very difficult to determine before the installation is made, for the reason that it is usually impossible to ascertain exactly how much of our total power will be transmitted in the future, as this is usually dependent upon an unknown demand. In addition to this, the value per K. W. of the power wasted will frequently be almost nothing in the beginning, when a large water power is available and there is a demand for but a small portion of it, but later the value per K. W. of the energy wasted would probably be much greater.

Thus, while we can determine with absolute accuracy the Minimum First Cost, the question of the Most Economical First Cost is a question almost entirely for the investor to decide. We should be able to tell him not only the minimum first cost and its corresponding percentage of loss, but also the cost corresponding to any other loss than that demanded for the minimum cost.

In order to accomplish this I have designed CHART 2, which gives not only the cost of plant and necessary percentage of loss for any case, of initial E. M. F. and distance under the conditions of Minimum First Cost, but also gives the cost of plant for the given initial E. M. F. and distance with any other percentage of loss.

Thus if, as in Example 1, the distance is 50,000 feet and the initial E. M. F. 3,000 volts, we find, by examining the curve in which the initial E. M. F. equals 60 volts per 1,000 feet, that the minimum first cost of plant will be realized when we operate at 30 per cent. loss, and that the corresponding cost of generator and conductor is \$82.50, making the total cost of generator, conductor and motor \$115.50.

We also learn that if, with the same initial E. M. F. and distance, we operate at various losses, the cost of generator and conductor varies as follows:

30 per cent. loss....	\$82 50
25 " "	83 20
20 " "	87 20
15 " "	90 60
10 " "	119 00

If, now, we have a superabundance of water power and are transmitting but a small fraction of it and the value of the energy wasted is consequently negligible, we would do

CHART NO. 1.

TRANSMISSION OF POWER.

BY H. WARD LEONARD.

Showing Minimum First Cost of Plant, under Varying Distances and Initial E. M. F.'s.

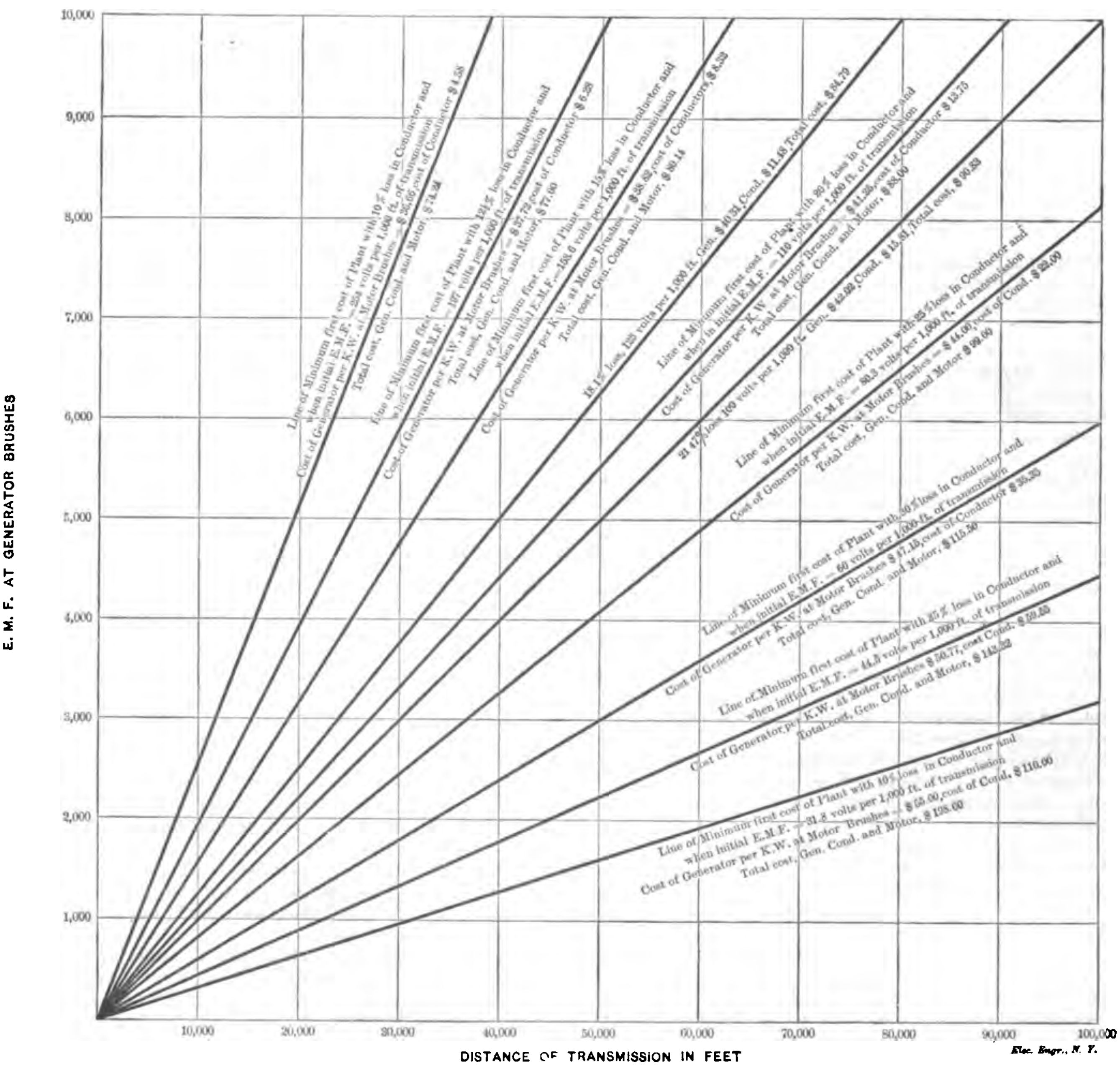
D = Distance of transmission in feet.
E = Initial E. M. F.
V = Volts lost in transmission.
G = Cost of dynamos per $K.W.$ at brushes.
L = Cost of bare copper in cents, per lb.
$\frac{A_M}{K.\ W.}$ = Cost of generator per $K.W.$ at motor brushes under conditions of minimum first cost.
$\frac{B_M}{K.\ W.}$ = Cost of conductor per $K.W.$ at motor brushes under conditions of minimum first cost.

Under conditions of minimum first cost of plant and when G = \$33.00 and L = 20 cents

$$D^2 = \frac{123{,}750\,V^2}{100 - 2\,P};$$

$$\frac{A_M}{K.\ W.} = \frac{D^2\,L\,(E - 2\,V)}{750\,V^2\,(E - V)} = \frac{D^2\,L\,(100 - 2\,P)}{750\,V^2\,(100 - P)};$$

$$\frac{B_M}{K.\ W.} = \frac{G\,E\,V}{(E - V)\,(E - 2\,V)} = \frac{100\,G\,P}{(100 - P)\,(100 - 2\,P)}.$$



better to operate at 30 per cent. loss and reduce our investment to a minimum. But if our power be limited and valuable so that the value of the energy wasted becomes an important consideration, we must then, for the highest economy, operate at such a loss in conductors that, although the cost of plant may not be a minimum, the sum of the interest and depreciation on such cost, plus the value of the energy wasted, will be a minimum.

It will be evident that when such sum is a minimum we will be operating at the highest economy. To determine this minimum, let us call I the rate of interest and depreciation on the investment, expressing I in per cent. Let U

be the value of 1 K. W. at the brushes of the motor, used as it will be used in practice. Then from (7) we have

$$\left.\begin{array}{l}\text{Interest and depreciation on}\\ \text{capital invested in genera-}\\ \text{tor and conductor per K. W.}\\ \text{at motor brushes}\end{array}\right\} = \frac{I}{100}\left(\frac{G\,E}{E-V}+\frac{D^2\,L}{750\,V(E-V)}\right) \quad (18)$$

The value per K. W. at motor brushes of the energy wasted in the conductor per annum will be $\frac{V\,U}{E-V}$ (19)

The sum of (18) + (19) is that portion of the cost of operating subject to variation by a variation in the loss in the line, and to learn when this is a minimum we will place the first differential of

$$(18) + (19) = 0.$$

Doing this, we find that the equation expressing the condition of Minimum Operating Expenses, or, in other words, Maximum Economy of Operation, is

$$D^2 = \frac{750\ E\ V^2\ (I\ G + 100\ U)}{L\ I\ (E-2\ V)}. \quad (20)$$

From this, calling B_s the cost of conductor under conditions of maximum economy, we find

$$B_s = \frac{E\ V(I\ G + 100\ U)}{I(E-V)\ (E-2\ V)}. \quad (21)$$

and calling A_s the cost of generator under conditions of maximum economy, we find,

$$A_s = \frac{D^2\ L\ (E-2\ V)}{750\ V^2\ (E-V)} - \frac{100\ E\ U}{I\ (E-V)}. \quad (22)$$

From this relation we can plot curves which will enable us to quickly determine the conditions of maximum economy in practice. A set of such curves is shown in CHART 3.

CHART 3 is designed for transmissions in which 100 volts are allowed per 1,000 feet of transmission. Two sets of curves are plotted, one, marked X, assuming the combined interest and depreciation to be 10 per cent. per annum, and the other set assuming 15 per cent. for these items.

The value of the energy wasted is also plotted when the value of the energy is $5, $10, and $20 respectively, per kilo-watt at motor brushes; and then each of these latter curves is combined with each of the former, giving as a result the operating cost under six different conditions and indicating the maximum economy in each case, and also the variation in the expense due to any deviation from the loss corresponding to the maximum economy.

Example 3. For instance, suppose a transmission of 30,000 feet with 3,000 volts initial E. M. F., and suppose we value interest and depreciation at 15 per cent. per annum. Also, suppose our power to have a value at first of $5 per K. W. at generator brushes. By CHARTS 2 and 3 we find that the maximum economy will be realized when we operate at 17 per cent. loss, although the minimum first cost of plant alone would be realized when we operate at 21.47 per cent.

If later on in this same plant the increasing scarcity of power makes its value $20, instead of $5, per K. W. we find that we must arrange our plant as we increase it, so that the loss shall be 11½ per cent, since by CHART 3 we find we will then be operating at the maximum economy.

It will be seen that by the use of these formulæ and their resultant curves any problem in the transmission of power can be readily and accurately determined. The value of these curves will be evident, when attention is called to the fact that there is in use in this country a plant put in by one of the leading companies, in which the equivalent of the following conditions prevails: Initial E. M. F. 2,200 volts; distance 50,000 feet; loss in conductor 50 per cent. The company who installed this plant even now consider it satisfactory; yet we see from CHART 2, by examining the curve of 44 volts per 1,000 feet, that with exactly the same cost of generator and conductor they could have operated at 22 per cent. loss instead of 50 per cent., making a net gain in the power delivered of 56 per cent.; or they might have made a saving in their investment of $10 per kilo-watt delivered by conductor with an increase in power of 30 per cent., had they worked at 35 per cent. loss in conductor, which is that required for minimum first cost.

The following examples will serve to give a clear idea of the use of these curves:

Example 4. Suppose a proposed transmission of 30,000 feet, and that 6,000 volts is the highest voltage we have dynamos for; that is, 200 volts per 1,000 feet. By CHART 1 we learn that for minimum first cost we must lose 12½ per cent. in conductor. That the cost of bare copper conductor will be $6.28 per K. W., that of the generator $37.72; total cost of generator, conductor and motor $77.

Example 5. If we have but 3,000 volts available for the initial E. M. F., we must, for the mimimum first cost, lose 21½ per cent. The cost of conductor will be $15.81, that of generator, $42.02; and that of generator, conductor and motor $90.83.

Example 6. If, instead of 12½ per cent. loss, we wish to lose less, we find from CHART 2 that the cost of such generator and conductor will be, as follows: 6,000 volts and 5 per cent., $50; 6,000 volts and 10 per cent., $43.25. Knowing the value of the power and the rate of interest and depreciation, we can determine which loss to operate at. It will be noticed that with 6,000 volts, we should, under no circumstances, lose more than 12½ per cent. in the conductor, as with greater losses not only the waste of energy increases, but also the cost of plant.

There are four factors in a transmission plant—the distance, the initial E. M. F., the percentage of loss, and the cost of plant, and knowing any three we can by CHART 2 get the fourth. We have already considered the case of fixed distance initial E. M. F. and per cent. of loss.

Suppose now, distance, loss, and cost be fixed and we want to determine initial E. M. F. necessary.

Example 7. Suppose distance as before 30,000 feet, and that the loss must not exceed 20 per cent., and that the cost of generator and conductor must be $55 per K. W. invested in the best possible way. By CHART 2 we find that with 110 volts per 1,000 feet, that is, 3,300 volts initial E. M. F., our loss will be exactly 20 per cent. and the cost exactly $55. Also, that with 7,620 volts initial we need only lose 10 per cent., and still the cost will be only $41; and by using 3,750 volts and 11 per cent. the cost will still be but $55; also by using 6,000 volts initial and 3½ per cent. loss the cost would be only $55.

The next case will be where distance, initial E. M. F. and capital to be invested are fixed, and we wish to determine the percentage of loss necessary.

Example 8. Suppose distance 30,000 feet; initial E. M. F., 1,800 volts; capital to be invested, $100 per K. W. for generator and conductor. Having 60 volts per 1,000 feet available, we find that we must operate at 14 per cent. loss.

Now, suppose investment, initial volts and permissible loss to be fixed, and we want to find the maximum possible distance of transmission.

Example 9. Suppose investment in generator and conductor fixed at $60; initial volts, 2,400; percentage of loss, 15 per cent. We find that the maximum distance corresponding is 24,000 feet.

Let us now briefly examine the formulæ and laws which have been referred to by Mr. Badt in his "Electric Transmission Hand-Book." Mr. Badt quotes freely from a paper by Mr. F. J. Sprague, read before the Franklin Institute, which was printed in the *Journal* of the Franklin Institute for April, 1889. By careful examination of the paper it will be found that, after having assumed the value of the E. M. F. at the motor brushes and the distance also being fixed, the error is made afterward of considering the results obtained as applicable to cases in which these values are variable. Hence it is not surprising that we find Mr. Sprague saying: "That is, with fixed conditions of cost and efficiency of apparatus the number of volts fall to get

CHART No. 2.

TRANSMISSION OF POWER.

BY H. WARD LEONARD.

Showing Minimum First Cost of Plant for any Distance and Initial E. M. F., *with Corresponding Necessary Loss in Conductor, and also Showing Variation in Such Cost Occasioned by Losses other than those Necessary for Minimum First Cost.*

D = Distance of transmission in feet.
E = Initial E. M. F.
V = Volts lost in transmission.
G = Cost of dynamos per $K. W.$ at brushes.
L = Cost of bare copper in cents, per lb.

$\frac{A_M}{K. W.}$ = Cost of generator per $K. W.$ at motor brushes under conditions of minimum first cost.

$\frac{B_M}{K. W.}$ = Cost of conductor per $K. W.$ at motor brushes under conditions of minimum first cost.

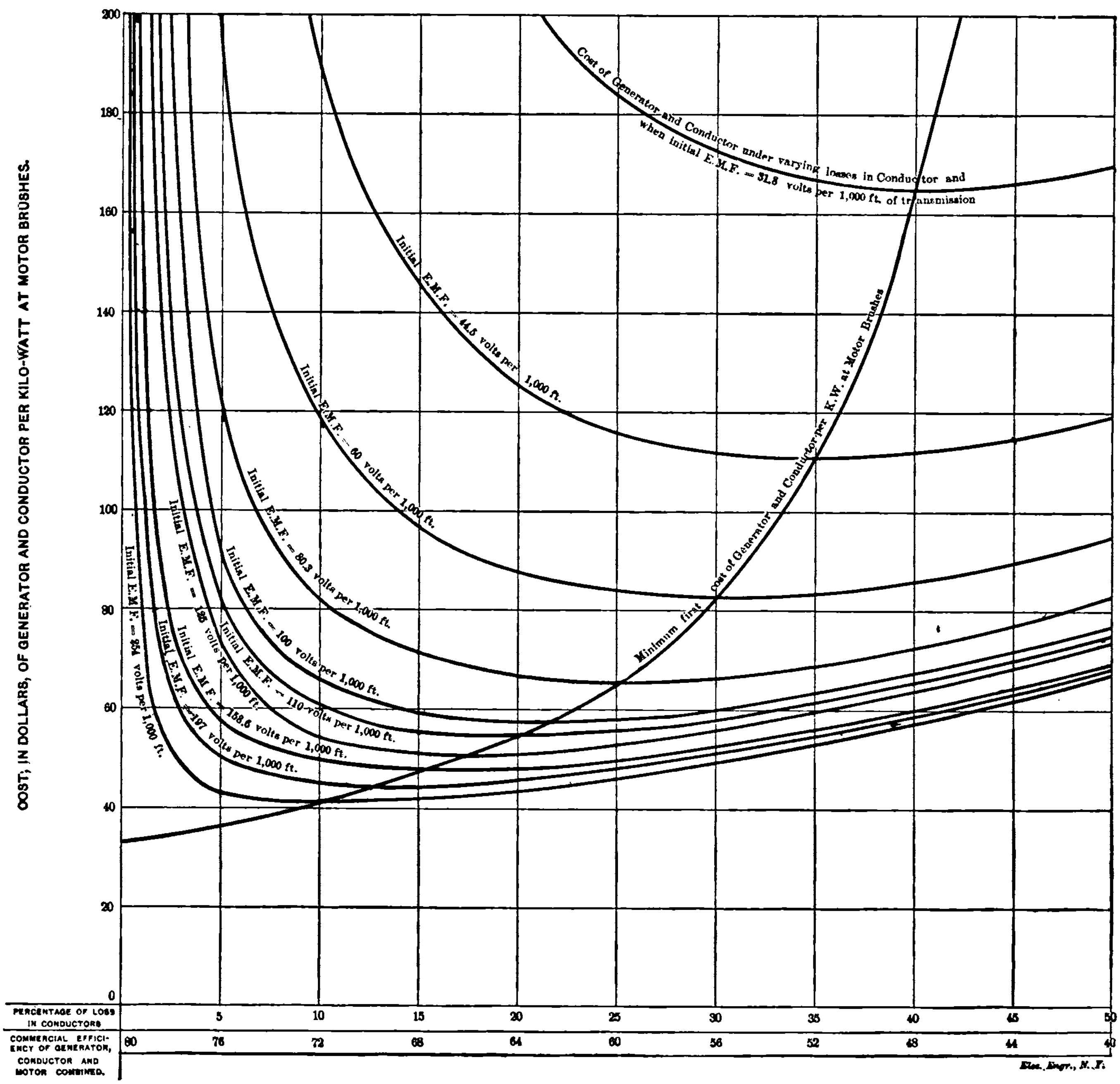
Cost (in dollars) of bare copper conductor per $K. W.$ at motor brushes $= \frac{D^2 L}{750\, V (E - V)}$ (general case).

Under conditions of minimum first cost of plant and when $G = \$33.00$ and $L = 20$ cents,

$$D^2 = \frac{123{,}750\, V^2}{100 - 2\,P}.$$

$$\frac{A_M}{K. W.} = \frac{D^2 L (E - 2\,V)}{750\, V^2 (E - V)} = \frac{D^2 L\, (100 - 2\,P)}{750\, V^2\, (100 - P)}.$$

$$\frac{B_M}{K. W.} = \frac{G. E. V.}{(E - V)\,(E - 2\,V)} = \frac{100\, G. P.}{(100 - P)(100 - 2\,P)}.$$



the minimum cost is a function of the distance alone and is independent of the E. M. F. at the motor, a somewhat startling conclusion."

In the light of what we have already seen it will be evident that this statement is entirely incorrect. To make this more clear (*Example* 10) suppose that with the same distance as in *Example* 1, that is, 50,000 feet, and the same efficiency of apparatus, that is, 30 per cent. loss in conductor, we use the initial E. M. F. of 6,000 instead of 3,000, and consequently have an E. M. F. at the motor of 4,200 volts, instead of 2,100 volts, as before. Now, according to Mr. Sprague, the "minimum cost of plant is a function of the distance alone and is independent of the E. M. F. used at the motor;" yet it will be evident that in "*Example* 10" the cost of the conductor is only ¼ of that in *Example* 1 and the cost of the generator is the same; hence the total cost is much reduced. In other words, while, if we fix the initial E. M. F. and distance, there is a definite loss in conductor at which we must operate in order to have a minimum first cost of plant, it by no means follows that if we fix the distance and percentage of loss there is a definite initial E. M. F. which corresponds to a minimum first cost of plant; for, evidently, the higher we make the initial E. M. F., meantime keeping the percentage of loss constant, the more we reduce the cost of plant, and there is no minimum value under these conditions.

Following out the same error, Mr. Sprague also lays down the following incorrect law: "With any fixed couple and commercial efficiency the cost of the wire should bear a definite and fixed ratio to the cost of the generating plant." It will be evident from what we have just seen regarding the preceding law, that this one is equally as incorrect and formulæ (13) and (15) clearly indicate the impossibility of either of them being correct. In his paper Mr. Sprague gives several tables based upon these laws, and since this same error is maintained throughout, his results are entirely erroneous.

Mr. Badt has not only followed Mr. Sprague blindly, but has gone much further and has finally brought up with such remarkable results, that we find him, after stating some of these surprising conclusions, saying: "At the same time it seems somewhat startling that for the minimum cost of the installation under given conditions as mentioned before (*i. e.*, fixed cost and efficiency of apparatus), the volts lost in the conductor are dependent upon the distance alone."

It seems almost impossible that such a statement as this could be seriously made by an electrical engineer of practical experience, yet we find Mr. Badt giving examples and tables in which it is surprising that he did not see the absurdity of this statement. For instance, on page 28 he gives "*Example* 1. Distance, including 5 per cent. for sag, 7,000 feet; E. M. F. at motor terminals, 500 volts. What must be the loss in the wire and E. M. F. of generator for minimum cost of plant?"

Mr. Badt, by the aid of Mr. Sprague's laws, with his own additions, concludes that he must have 20 per cent. loss in conductor; hence 625 volts at the generator. Since the E. M. F. at the motor is fixed, is it not evident that the higher the initial E. M. F. and the less the percentage of loss in the line, the less will be the cost of plant? In other words, if the cost be a certain amount at 20 per cent. loss in conductor with 625 volts initial, would it not be less with 10,000 volts initial and 1,000 volts loss in conductor, that is, 10 per cent?

Similarly, "*Example* 2. Distance (including 5 per cent. for sag), 50,000 feet; we want to obtain at least 55 per cent. (efficiency from generator pulley to motor shaft). What is the voltage to be employed at motor and generator for minimum cost of plant?"

Mr. Badt finds that the E. M. F. at generator must be 2,741 and that at the motor 1,850, with a loss in conductor of 32.5 per cent. Is it not evident that by using 5,482 volts at generator and 3,700 at motor the cost of generator is the same and the cost of conductor only ¼ what it was, and that there is no limit to the possible reduction in cost of the conductor, and hence no minimum value?

Mr. Badt, following the law that, "the number of volts to get the minimum cost of plant is a function of the distance alone," finds that for every 1,000 feet we must lose 17.5 volts, and with fixed cost and efficiency of apparatus no other factors need be considered. This, certainly, has the beauty of simplicity, and the tables built upon this conclusion leave little to be desired in that direction; but the transmitter of power who follows these tables will pay heavily for his faith in them.

Another law which Mr. Badt deduces, after making the assumption that "$\frac{D}{V}$, the relation of distance to volts drop for minimum cost of plant, is a constant," appears on page 37, and is as follows: "For minimum cost of plant the total weight of the conductor per horse power delivered by the motor shaft remains the same at a certain percentage of loss in the conductor, regardless of the voltage of motor and the distance." This involves the same erroneous assumptions and is evidently absurd, as is another law on page 39: "For minimum cost of plant the weight of the conductor depends only on the percentage of loss in the conductor and the number of mechanical horse power delivered by the motor."

Mr. Badt, on page 42, quotes from Mr. Sprague another equally misleading rule, viz: "For minimum initial cost of plant, and assuming certain prices per horse power of motors, generators and power plants (all erected and ready for operation), and assuming a certain price per pound of copper (delivered at the poles), the total cost of plant, excluding line construction, is a constant for a certain efficiency of the electric system, no matter what the E. M. F. of the motor and the distance may be." The absurdity of this is evident from what we have seen and is clearly shown by CHART 2.

We now come to a consideration of the conditions governing the maximum economy of operation.

Sir William Thomson, in a paper entitled "The Economy of Metal Conductors of Electricity," read before the British Association in 1881, stated the following law: "The most economical area of conductor will be that for which the annual interest on capital equals the annual cost of energy wasted."

This law has been accepted ever since that date with slight modifications, but upon close and practical investigation it proves to be entirely incorrect as applied to maximum economy of operation of a plant, for the very surprising reason that no account whatever is taken of the fact that the cost of the generator per horse power transmitted will vary as the loss in the line varies.

Since the variation in the cost of the generator is the principal factor, it is not surprising that the correct minimum, and that obtained from Thomson's law, are widely different. In fact, it will often be impossible to apply Thomson's law, as it will frequently occur that the interest on the plant, even when at its minimum cost, will far exceed the value of the energy wasted; and, evidently, if we depart from the condition of minimum first cost with an endeavor to increase the loss and thereby to make the value of the increasing loss in the line finally equal the interest on the increased cost of plant—since we are increasing both items, we evidently are not approaching a minimum value. CHART 3 clearly shows that, frequently, the curve of interest and depreciation and the curve of value of energy wasted will never cross, and hence will never be equal under any conditions of loss.

Formulæ (21) and (22) clearly show that no such relation can exist, and CHART 3 makes it evident graphically. *Example* 11. We find that, by Sir William Thomson's law, if the power is worth \$20 per K. W at generator brushes, and the interest and depreciation is 10 per cent., we should work at 22½ per cent. loss; whereas, in reality, for the maximum economy we should work at 10 per cent.

We also find that in all the seven other cases indicated

CHART No. 3.

TRANSMISSION OF POWER.

BY H. WARD LEONARD.

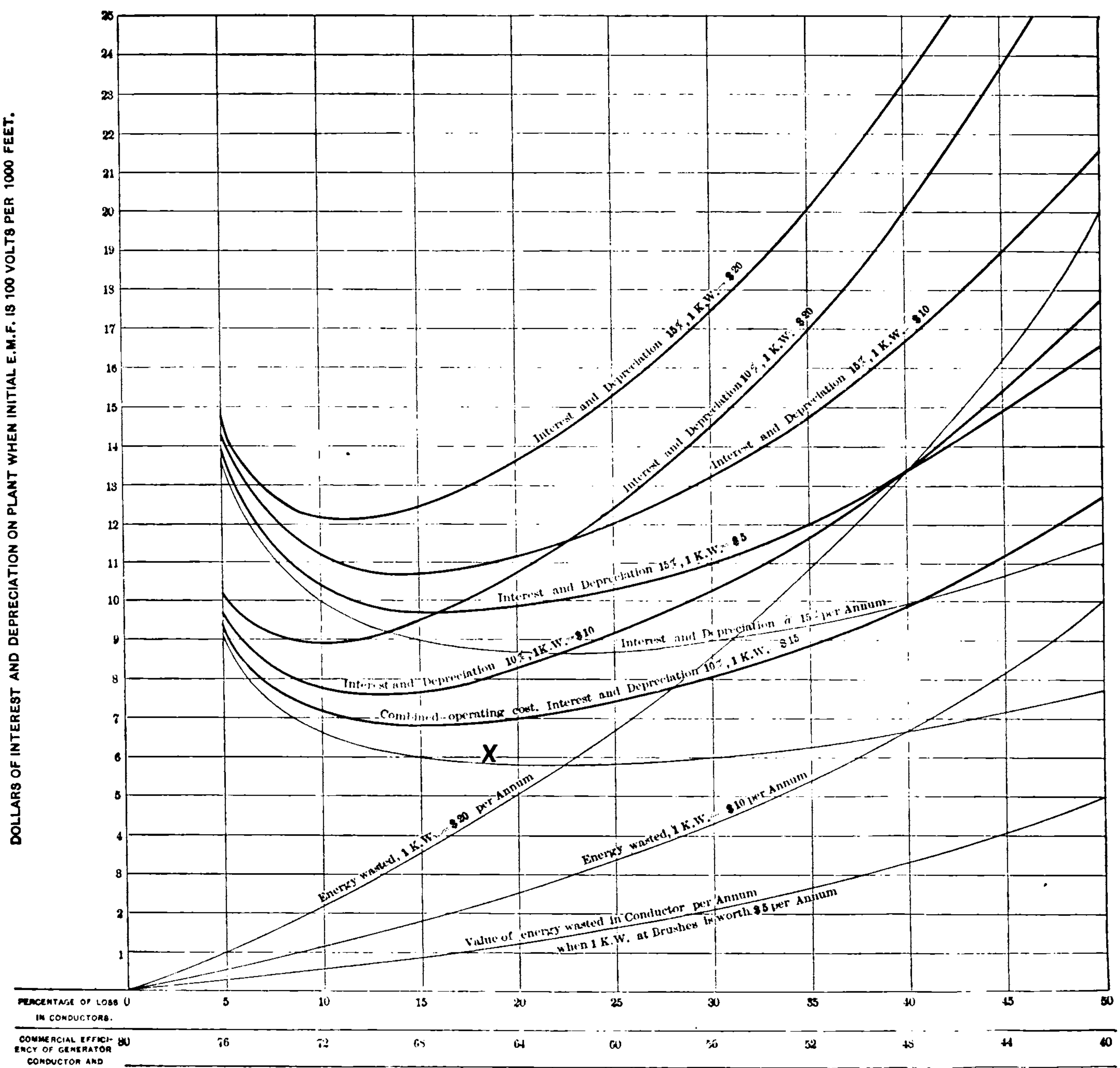
Showing Maximum Economy of Operation when 100 *Volts per* 1,000 *Feet are Used, and when Interest and Depreciation on Plant is* 10 *per cent. and* 15 *per cent., and when Value of Power at Generator Brushes is* $5.00, $10.00, *and* $20.00 *per K. W., respectively.*

A_2 = Cost of generator per *K.W.* at motor brushes under conditions of maximum economy of operation.
B_2 = Cost of conductor per *K.W.* at motor brushes under conditions of maximum economy of operation.
L = cost of bare copper in cents per lb.
D = Distance of transmission in feet.
E = Initial E. M. F.
V = Volts lost in transmission.
G = Cost of dynamo per *K.W.* at brushes.
I = Interest and depreciation on cost of generator and conductor per *K.W.* at motor brushes.
U = Value of 1 *K.W.* per annum at brushes of motor as used.

$$D^2 = \frac{750\,E\,V^2\,(I\,G + 100\,U)}{L\,I\,(E - 2\,V)}$$

$$B_2 = \frac{E\,V\,(I\,G + 100\,U)}{I\,(E - V)\,(E - 2V)}$$

$$A_2 = \frac{D^2\,L\,(E - 2\,V)}{750\,V^2\,(E - V)} - \frac{100\,E\,U}{I\,(E - V)}$$



by the curves it is impossible to apply Thomson's law, as we cannot, by any means, make the interest on capital outlay and the value of energy wasted equal.

Both Kapp and Ayrton and Perry have discussed Thomson's law and made certain limitations and modifications, but have only complicated, and not corrected, it. In Mr. Badt's present work he refers to Kapp's latest formulæ contained in a lecture of March 2, 1891, a copy of which lecture I have not as yet seen; hence the formulæ quoted by Mr. Badt cannot be commented on by me further than that Mr. Kapp's formulæ as given by Mr. Badt points to one fact which is very evident from formulæ (13) and (21), Chart I amely, that under no circumstances will it be economical to lose more than 50 per cent. in the conductor, for when $E = 2V$, we have $E - 2V = 0$, and an infinite cost of conductor as a resulting condition.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—XIII.

BY

Chas. Steinmetz.

The ideal hysteretic current has the same phase as the secondary current. But the secondary current, C_1 lagging behind the secondary E. M. F., E_1 by an angle δ, because of the self-induction, the line $\overline{KF}$ makes an angle δ with the horizontal line. This angle is a maximum, almost $= 90°$ for short circuit, and decreases for increasing secondary resistance, reaching zero for open circuit.

Thus we produce in this diagram, Fig. 26,[1] the curve of magnetic lag, k, by adding the ideal hysteretic current $\overline{KF}$ on $\overline{OF}$ under the angle δ, of shifting of phase of secondary current, and thereby derive a somewhat different shape of curve k. As seen, this curve k does not start at the zero point O, but at a higher M. M. F.

To produce now the diagram for any value of F, we draw line $\overline{KF}$ under the angle δ, which corresponds to this particular value of F, and continue $\overline{KF}$ to its intersection with the circle c at C; then $\overline{KC}$ gives the secondary M. M. F. or the secondary current $= \overline{OC_1}$ and the primary current, $C = \overline{OC}$ intersects the quadrant e in the primary resulting or heating E. M. F., E. F gives the induced E. M. F., E_1, and E_1 and E the primary impressed E. M. F., E_0.

Drawing a half-circle with $\overline{OE_1}$ as diameter, gives us the E. M. F. of self-induction of the secondary circuit $E_s = \overline{e_1 e_r}$ and the heating or resulting secondary E. M. F., $E_r = \overline{OE_r}$ and in $\frac{E_r}{C_1} = r_1$ the secondary resistance.

In producing thus the diagram for different secondary resistances, r_1, we derive the curve of resulting secondary E. M. F., e_r, of secondary current, that is, secondary M. M. F., c_1, of primary impressed E. M. F., e_0, etc.

From this diagram Fig. 26, we see that the shifting of phase of the secondary current is a maximum for short-circuit, and then decreases with increasing resistance r_1, first very fast, then slower, reaching zero at open circuit. Hence for short-circuit the secondary current is almost entirely independent of the secondary resistance, r_1, but is determined by the secondary self-induction.

The secondary current decreases for increasing resistance, r_1, but first very slowly, and only after the self-induction of the secondary circuit has become imperceptible the decrease of secondary current becomes more marked and more rapid.

The ratio of currents $\frac{C_1}{C}$ therefore, does not approach the ratio of transformation, $\frac{n}{n_1}$ for decreasing resistance, but is considerably smaller, and is given in the accompanying table.

Even for short-circuit, the induced E. M. F., E_1, and therefore the resulting M. M. F., F, are quite considerable. The primary impressed E. M. F., E_0 is even, for short circuit, considerably larger than the heating E. M. F. accounts for. The phase of the primary impressed E. M. F. decreases with increasing secondary resistance, r_1.

The phase of the primary current is a maximum for short-circuit, decreases with increasing resistance, reaches a minimum, and increases again to a maximum for open circuit.

The difference of phase between primary current and impressed E. M. F. is a maximum for short-circuit, decreases, passes a minimum, and increases again to a maximum for open circuit.

In Fig. 26, the diagrams are produced for:

0. short circuit: $r_1^0 = .8$ ohms.
1. $r_1^1 = 6$ "
2. $r_1^2 = 12$ "
3. $r_1^3 = 34$ "
4. open circuit: $r_1^4 = \infty$ "

To compare the compounding of this transformer with that of Fig. 24, which has no self-induction in the secondary circuit, the dependence of the curves of secondary current and of primary impressed E. M. F., upon the electric conductivity are shown in diagram, Fig. 25, curve I., corresponding to the transformer without self-induction in the secondary circuit, in Fig. 24, and curve II., corresponding to the transformer with self-induction in the secondary circuit, in Fig. 26. From the diagram, Fig. 26, we derive the values of the electric quantities of the converter.

		0.	1.	2.	3.	4.	
Primary current, C	=	65	65	65	65	65	amp.
Primary impressed E. M. F., E_0	=	35	55	76	135	214	volts.
Primary resulting E. M. F., E	=	20	20	20	20	20	volts.
Secondary current, C_1	=	52.5	50.5	47.5	36	0	amp.
Induced secondary E. M. F., E_1	=	26	40	60	120	208	volts.
Resulting secondary E.M.F., E_r	=	4	31	55	108	208	volts.
Resulting M. M. F., F	=	1560	2400	3600	7200	12480	amp. turns.
Angle of magnetic lag, α	=	5°	17°	20°	18°	16°	
Differ. of phase bet. prim. cur. and impressed E. M. F., ω	=	47°	32°	29°	37°	70°	
Differ. of phase bet. sec. cur. and induced E. M. F., δ	=	81°	39°	23°	9°	0°	
Effective secon. energy, $\frac{E_r C_1}{2}$	=	105	788	1306	1944	0	watts.
Eff. prim. energy, $\frac{E_0 C \cos \omega}{2}$	=	777	1514	2161	3486	2379	watts.
Ratio of transformation, $\frac{C_1}{C}$	=	.81	.78	.73	.55	0	

It will be understood, that the compounding of the transformer for constant current, and for constant potential, in practice is much better fulfilled than in the transformer here under consideration, where the constants were chosen unusually unfavorable, to show even the losses on a large scale.

AN ELECTRICAL TRANSFORMER FOR MEDICAL PURPOSES.

In a recent number of the *Lancet* appears an illustrated description of an electrical transformer for surgical, medical and dental purposes, which has been designed by A. B. Woakes, M. R. C. S., L. R. C. P. In the transformer there are three pairs of terminals, the first for supplying current to the electrical cautery, the second for illuminating a surgical incandescent lamp, and the third for supplying Faradic shocks, so that in one instrument the surgeon has at his command electricity for any of these three purposes. For the purposes of the cautery a maximum current of 20 amperes at 6 volts can be obtained.

1. For the figures referred to see the issues of August 12 and 26.

THE FRANKFORT INTERNATIONAL ELECTRICAL EXHIBITION—VI.

BY

Richard O. Heinrich.

YET another very compact and useful instrument is the slide-wire bridge for very low resistances. Fig. 1 shows the instrument itself, Fig. 2 the diagram of connections, and Fig. 3 the diagram for the use of the instrument. It will be seen from Fig. 2 that the arrangement is that of the Thomson method of testing low resistances. B is the battery, with key C in the circuit; also the standard slide-wire D and the test-piece W, the resistance of which, X, between *b* and *b* is to be measured. Two separate circuits are branched off at the points *o* and *a* of the slide-wire, and *b* and *b* of the test-wire forming the sections *m*, *n*, *p*, *o*, connected by the mirror galvanometer G with the key *C* in the circuit. Decadic resistances only can be inserted in the branches *m*, *n*,

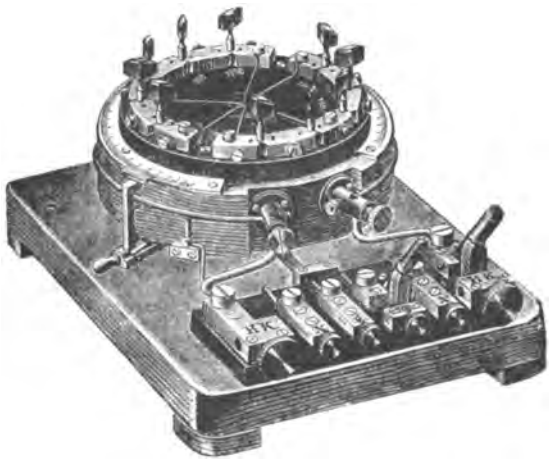


Fig. 1.—Slide-Wire Bridge for Low Resistances.

p, *o*. If the resistance $m = n$ and $p = o$ no current flows through the galvanometer G, provided the resistance N between *e* and *a* is equal to the resistance X between *b* and *b*. The resistance N is made variable with a sliding contact; in this way resistances up to the total resistance of the slide-wire may be measured. If, however, N and X are very different, *m*, *n*, *p*, *o* are varied, but always in such a

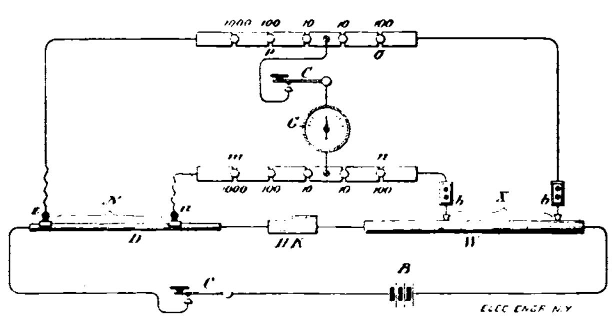


Fig. 2.—Slide-Wire Bridge for Low Resistances.

way that $n : m = o : p$, and then, if no current flows through the galvanometer, $X = N\frac{n}{m} = N\frac{o}{p}$.

Since $\frac{n}{m}$ and $\frac{o}{p}$ have decadic values, and the resistance in ohms of the slide-wire is directly read off the scale on the instrument, the values of X are easily and quickly obtained in ohms also.

The instrument is especially valuable for the measurement of resistances of dynamos, cables with large cross-sections, and for the determination of specific resistances. The range of the instrument in connection with a good mirror galvanometer is from 0.000001 to 0.1 ohm.

In connection with these instruments may be mentioned a rheostat made for the special purpose of taking a current

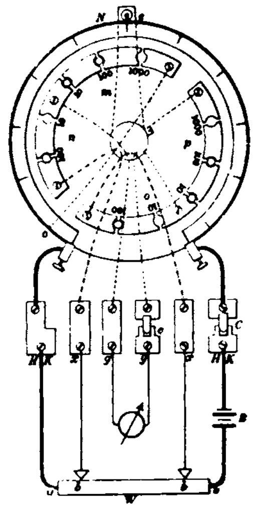


Fig. 3.—Slide-Wire Bridge for Low Resistances.

up to 3,000 amperes. A set of 18 tubes of different sizes are arranged around an iron water reservoir. These tubes are connected in pairs by many metal pieces, as shown in Figs. 4 and 5, the length of tube in circuit being regulated by the slide contact. The tubes communicate with the interior of the reservoir through the metal pieces and short china tubes, so that they are always filled with water to the same

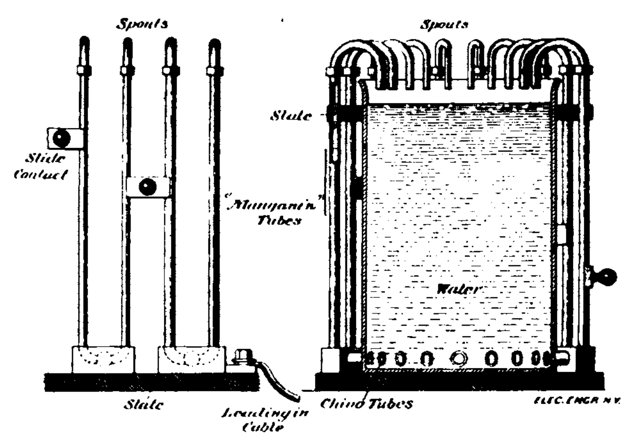


Fig. 4.—"Manganin" Rheostat for 3,000 Amperes.

height as the reservoir. These tubes are well insulated from each other since they rest on, and are held, by a slate base and a slate collar. If the tubes are heated by a very heavy current passing through part of them, the water is heated and eventually boils. The boiling water rushes through the attached spouts into the large reservoir, and in this way heating above the boiling point of water cannot take place.

The material used for these tubes is the so-called "manganin," a manganese-nickel bronze, with a very small temperature coefficient.

As soon as information can be obtained I shall give some particulars about this alloy, which seems to be very similar to the alloy invented by Mr. Edward Weston, who is using it very effectively in his standard ammeters and voltmeters, avoiding in this way temperature corrections.

NOTES ON A UNIPOLAR DYNAMO.

BY

Nikola Tesla

It is characteristic of fundamental discoveries, of great achievements of intellect, that they retain an undiminished power upon the imagination of the thinker. The memorable experiment of Faraday with a disc rotating between the two poles of a magnet, which has borne such magnificent fruit, has long passed into every-day experience; yet there are certain features about this embryo of the present dynamos and motors which even to-day appear to us striking, and are worthy of the most careful study.

Consider, for instance, the case of a disc of iron or other metal revolving between the two opposite poles of a magnet, and the polar surfaces completely covering both sides of the disc, and assume the current to be taken off or conveyed to the same by contacts uniformly from all points of the periphery of the disc. Take first the case of a motor. In all ordinary motors the operation is dependent upon some shifting or change of the resultant of the magnetic attraction exerted upon the armature, this process being effected either by some mechanical contrivance on the motor or by the action of currents of the proper character. We may explain the operation of such a motor just as we can that of a water-wheel. But in the above example of the disc surrounded completely by the polar surfaces, there is no shifting of the magnetic action, no change whatever, as far as we know, and yet rotation ensues. Here, then, ordinary considerations do not apply; we can not even give a superficial explanation, as in ordinary motors, and the operation will be clear to us only when we shall have recognized the very nature of the forces concerned and fathomed the mystery of the invisible connecting mechanism.

Considered as a dynamo machine, the disc is an equally interesting object of study. In addition to its peculiarity of giving currents of one direction without the employment of commutating devices, such a machine differs from ordinary dynamos in that there is no reaction between armature and field. The armature current tends to set up a magnetization at right angles to that of the field current, but since the current is taken off uniformly from all points of the periphery, and since, to be exact, the external circuit may also be arranged perfectly symmetrical to the field magnet, no reaction can occur. This, however, is true only as long as the magnets are weakly energized, for when the magnets are more or less saturated, both magnetizations at right angles seemingly interfere with each other.

For the above reason alone it would appear that the output of such a machine should, for the same weight, be much greater than that of any other machine in which the armature current tends to demagnetize the field. The extraordinary output of the Forbes unipolar dynamo and the experience of the writer confirm this view.

Again, the facility with which such a machine may be made to excite itself is striking, but this may be due—besides to the absence of armature reaction—to the perfect smoothness of the current and non-existence of self-induction.

If the poles do not cover the disc completely on both sides, then, of course, unless the disc be properly subdivided, the machine will be very inefficient. Again, in this case there are certain points worthy of notice. If the disc be rotated and the field current interrupted, the current through the armature will continue to flow and the field magnets will lose their strength comparatively slowly. The reason of this will at once appear when we consider the direction of the currents set up in the disc.

Referring to diagram in Fig. 1, *d* represents the disc with the sliding contacts B B′ on the shaft and periphery. N and S represent the two poles of a magnet. If the pole N be above, as indicated in the diagram, the disc being supposed to be in the plane of the paper, and rotating in the direction of the arrow D, the current set up in the disc will flow from the centre to the periphery, as indicated by the arrow A. Since the magnetic action is more or less confined to the space between the poles N S, the other portions of the disc may be considered inactive. The current set up will therefore not wholly pass through the external circuit F, but will close through the disc itself, and generally, if the disposition be in any way similar to the one illustrated, by far the greater portion of the current generated will not appear externally, as the circuit F is practically short-circuited by the inactive portions of the disc. The direction of the resulting currents in the latter may be assumed to be as indicated by the dotted lines and arrows *m* and *n*; and the direction of the energizing field current being indicated by the arrows *a b c d*, an inspection of the figure shows that one of the two branches of the eddy current, that is, A B′ *m* B, will tend to demagnetize the field, while the other branch, that is, A B′ *n* B, will have the opposite effect. Therefore the branch A B *m* B that is, the one which is *approaching* the field, will repel the lines of the same, while branch A B′ *n* B, that is, the one *leaving* the field, will gather the lines of force upon itself.

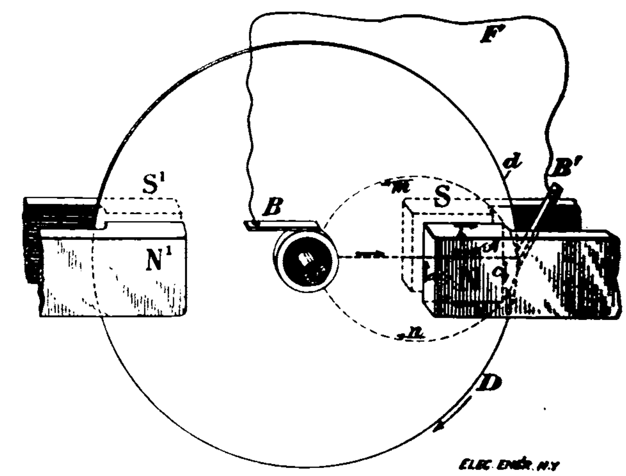
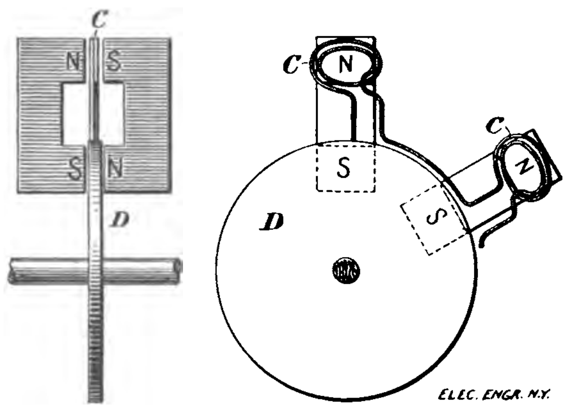


Fig. 1.

In consequence of this there will be a constant tendency to reduce the current flow in the path A B′ *m* B, while on the other hand no such opposition will exist in path A B′ *n* B, and the effect of the latter branch or path will be more or less preponderating over that of the former. The joint effect of both the assumed branch currents might be represented by that of one single current of the same direction as that energizing the field. In other words, the eddy currents circulating in the disc will energize the field magnet. This is a result quite contrary to what we might be led to suppose at first, for we would naturally expect that the resulting effect of the armature currents would be such as to oppose the field current, as generally occurs when a primary and secondary conductor are placed in inductive relations to each other. But it must be remembered that this results from the peculiar disposition in this case, namely, two paths being afforded to the current, and the latter selecting that path which offers the least opposition to its flow. From this we see that the eddy currents flowing in the disc partly energize the field, and for this reason when the field current is interrupted the currents in the disc will continue to flow, and the field magnet will lose its strength with comparative slowness and may even retain a certain strength as long as the rotation of the disc is continued.

The result will, of course, largely depend on the resistance and geometrical dimensions of the path of the resulting eddy current and on the speed of rotation; these elements, namely, determine the retardation of this current and its position relative to the field. For a certain speed there would be a maximum energizing action; then at higher speeds, it would gradually fall off to zero and finally reverse, that is, the resultant eddy current effect would be to weaken the field. The reaction would be best demonstrated experimentally by arranging the fields N S, N′ S, freely movable on an axis concentric with the shaft of the disc. If the latter were rotated as before in the direction of the arrow D the field would be dragged in the same direction with a torque, which, up to a certain point,



FIGS. 2 AND 3.

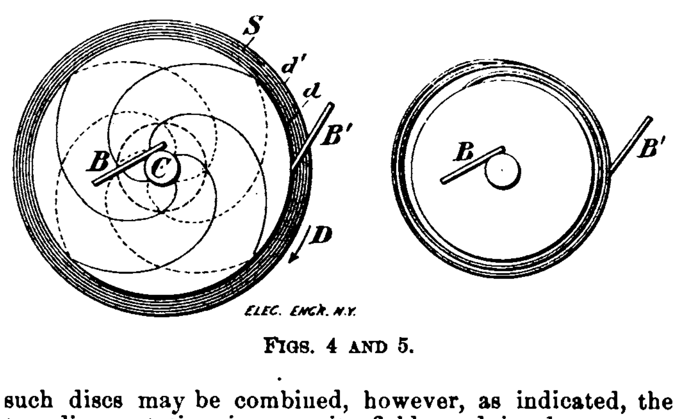
would go on increasing with the speed of rotation, then fall off, and, passing through zero, finally become negative; that is, the field would begin to rotate in opposite direction to the disc. In experiments with alternate current motors in which the field was shifted by currents of differing phase, this interesting result was observed. For very low speeds of rotation of the field the motor would show a torque of 900 lbs. or more, measured on a pulley 12 inches in diameter. When the speed of rotation of the poles was increased the torque would diminish, would finally go down to zero, become negative, and then the armature would begin to rotate in opposite direction to the field.

To return to the principal subject; assume the conditions to be such that the eddy currents generated by the rotation of the disc strengthen the field, and suppose the latter gradually removed while the disc is kept rotating at an increased rate. The current, once started, may then be sufficient to maintain itself and even increase in strength, and then we have the case of Sir William Thomson's "current accumulator." But from the above considerations it would seem that for the success of the experiment the employment of a disc *not subdivided* would be essential, for if there would be a radial subdivision, the eddy currents could not form and the self-exciting action would cease. If such a radially subdivided disc were used it would be necessary to connect the spokes by a conducting rim or in any proper manner so as to form a symmetrical system of closed circuits.

The action of the eddy currents may be utilized to excite a machine of any construction. For instance, in Figs. 2 and 3 an arrangement is shown by which a machine with a disc armature might be excited. Here a number of magnets, N S, N S, are placed radially on each side of a metal disc D carrying on its rim a set of insulated coils, C, C. The magnets form two separate fields, an internal and external one, the solid disc rotating in the field nearest to the axis, and the coils in the field further from it. Assume the magnets slightly energized at the start; they could be strengthened by the action of the eddy currents in the solid disc so as to afford a stronger field for the peripheral coils. Although there is no doubt that under proper conditions a machine might be excited in this or a similar manner, there being sufficient experimental evidence to warrant such an assertion, such a mode of exciting would be wasteful.

But a unipolar dynamo or motor, such as shown in Fig. 1, may be excited in an efficient manner by simply properly subdividing the disc or cylinder in which the currents are set up, and it is practicable to do away with the field coils which are usually employed. Such a plan is illustrated in Fig. 4. The disc or cylinder D is supposed to be arranged to rotate between the two poles N and S of a magnet, which completely cover it on both sides, the contours of the disc and poles being represented by the circles d and d' respectively, the upper pole being omitted for the sake of clearness. The cores of the magnet are supposed to be hollow, the shaft C of the disc passing through them. If the unmarked pole be below, and the disc be rotated screw fashion, the current will be, as before, from the centre to the periphery and may be taken off by suitable sliding contacts, B B′, on the shaft and periphery respectively. In this arrangement the current flowing through the disc and external circuit will have no appreciable effect on the field magnet.

But let us now suppose the disc to be subdivided spirally, as indicated by the full or dotted lines, Fig. 4. The difference of potential between a point on the shaft and a point on the periphery will remain unchanged, in sign as well as in amount. The only difference will be that the resistance of the disc will be augmented and that there will be a greater fall of potential from a point on the shaft to a point on the periphery when the same current is traversing the external circuit. But since the current is forced to follow the lines of subdivision, we see that it will tend either to energize or de-energize the field, and this will depend, other things being equal, upon the direction of the lines of subdivision. If the subdivision be as indicated by the full lines in Fig. 4, it is evident that if the current is of the same direction as before, that is, from centre to periphery, its effect will be to strengthen the field magnet; whereas, if the sub-division be as indicated by the dotted lines, the current generated will tend to weaken the magnets. In the former case the machine will be capable of exciting itself when the disc is rotated in the direction of arrow D; in the latter case the direction of rotation must be reversed. Two



FIGS. 4 AND 5.

such discs may be combined, however, as indicated, the two discs rotating in opposite fields, and in the same or opposite direction.

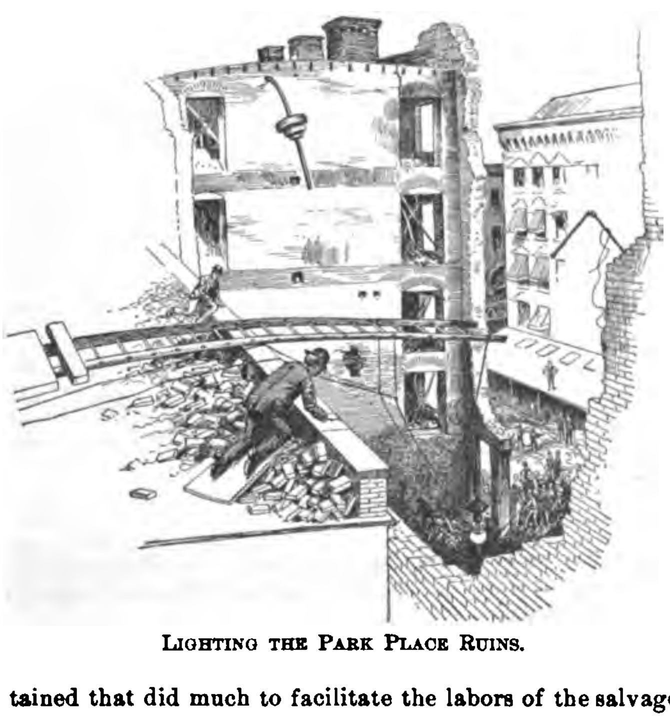
Similar dispositions may, of course, be made in a type of machine in which, instead of a disc, a cylinder is rotated. In such unipolar machines, in the manner indicated, the usual field coils and poles may be omitted and the machine may be made to consist only of a cylinder or of two discs enveloped by a metal casting.

Instead of subdividing the disc or cylinder spirally, as indicated in Fig. 4, it is more convenient to interpose one or more turns between the disc and the contact ring on the periphery, as illustrated in Fig. 5.

A Forbes dynamo may, for instance, be excited in such a manner. In the experience of the writer it has been found that instead of taking the current from two such discs by sliding contacts, as usual, a flexible conducting belt may be employed to advantage. The discs are in such case provided with large flanges, affording a very great contact surface. The belt should be made to bear on the flanges with spring pressure to take up the expansion. Several machines with belt contact were constructed by the writer two years ago and worked satisfactorily, but for want of time the work in that direction has been temporarily suspended. A number of features pointed out above have also been used by the writer in connection with some types of alternating current motors.

LIGHTING UP THE PARK PLACE RUINS.

On Saturday, August 22, the sudden collapse of a large building in Park Place, New York City, resulted in a fire and the loss of many lives, no fewer than 62 bodies having been recovered from the ruins. The accident was a very peculiar one, and still remains to be explained, although it is certain that the operation of a large number of heavy lithographic presses on the upper floors of the building was the chief cause, their weight and vibration at last bringing down the walls. It became desirable and necessary immediately after the accident to begin work on clearing away the ruins and recovering the bodies, and in order to push operations it was determined to dig all night. The great question lay in obtaining light for the purpose, and electricity was resorted to. Our sketch shows the very novel and ingenious manner in which one of the lights was suspended over the big hole in which the débris lay. A long ladder was placed on the roof of the building in the rear, so as to project considerably. This ladder was held down at one end by the scuttle of a skylight, weighted with stones, &c. Then the circuits were brought up from the street and stapled, and the lamp allowed to swing clear. By this means a very effective illumination was obtained that did much to facilitate the labors of the salvage corps.

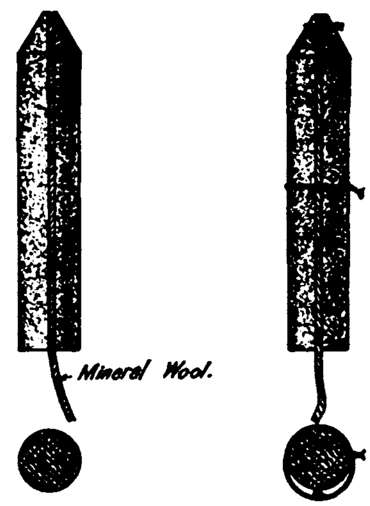


Lighting the Park Place Ruins.

One feature of this disaster which has so far escaped notice deserves mention. The building destroyed took its power from the shafting of The Electrical Engineer's composing and press-rooms, and the intervening wall had been pierced so that the line of shafting might be carried through. When the fire broke out after the collapse of the building, causing the Engineer to shut down, and exposing it to no small danger, that hole in the wall became a grave menace, and was closely watched by the firemen. Had the wind been from the west, or had the fire occurred at night, the existence of that hole would in all probability have caused the sacrifice of the Engineer building. But it is evident that in the distribution of power electrically, this dangerous piercing of fire walls is dispensed with, whether between adjoining buildings or between the various floors of one structure.

THE RICHARDS ARC-LIGHT CARBON.

In the construction of carbon electrodes for arc lamps, in which a liquid hydrocarbon is led to the burning end of the electrode, and there converted into gas to intensify and improve the quality of the light, it has heretofore been customary to employ tubular carbons having a longitudinal passage entirely surrounded by the material of the electrode and containing a capillary conductor of refractory material extending through the burning end of the electrode at the point where the heat is greatest.



The Richardson Arc Carbon.

In order to overcome certain objections attendant upon this construction, Mr. Walter S. Richards, of Natick, Mass., has adopted an arrangement having a refractory capillary conductor extending longitudinally along the exterior of the electrode, and exposed to the air throughout its entire length, so that it is only attacked and destroyed by the heat at the immediate point where the arc is formed, and the hydrocarbon is converted into gas more rapidly and completely.

In the accompanying drawings, Fig. 1 represents a side view of a carbon electrode and a capillary conductor, the electrode having in its surface a longitudinal groove, which receives the capillary conductor and retains it in place, at the same time exposing it to the atmosphere. Fig. 2 represents a section of Fig. 1.

Figs. 3 and 4 show the conductor as bearing on the surface of the electrode, no grooves being provided in the latter. In this case the conductor is held in place by independent fastenings, which are here shown as bands of wire. These fastenings will be readily consumed by the electric action when the electrode burns down to the point where they are located. It will be seen that by placing the conductor at the exterior of the electrodes the conductor is so exposed to the atmosphere that it cannot be destroyed by the heat at a point far enough from the arc to prevent the hydrocarbon gas carried by the conductor from properly entering the arc, and also that the free access of the atmosphere to the conductor facilitates the conversion of the liquid hydrocarbon into gaseous form.

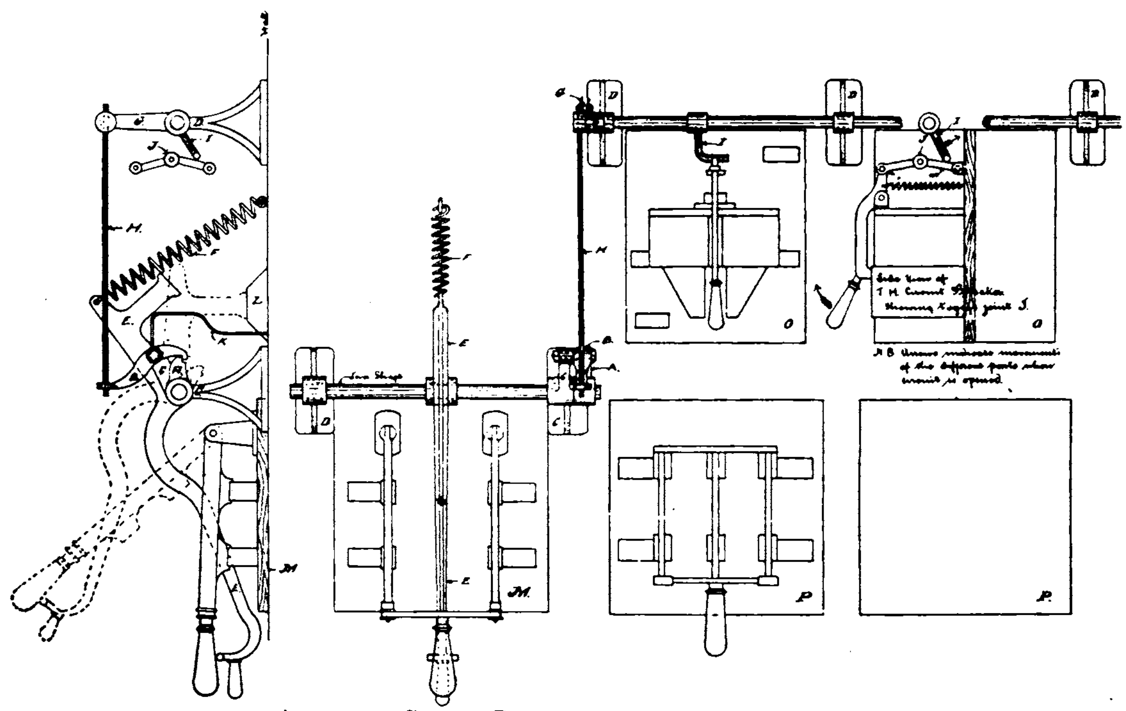
IMPROVED AUTOMATIC CIRCUIT BREAKER FOR RAILWAY CIRCUITS.

BY

Willis D. Gordon

Considerable trouble was at one time experienced in the power house of the Seattle Consolidated Street Railway Co., Seattle, Wash., by short circuits; besides this the machines were very heavily loaded and the circuit would frequently be opened by an overload. Sometimes the circuit breaker with which the station is equipped would refuse to act and, of course, the fuse on the generator would "go." This caused considerable inconvenience, and to obviate this the writer devised the arrangement, shown in elevation and side view in the accompanying engravings, for opening the main line switch.

The operation of the device is very simple. A shaft, to which is keyed the lever E and cam A, is supported by wall brackets, D and C. The lower arm of lever E is directly under the switch-handle, while the upper arm holds in tension (when set) the spring F. The trigger B is pivoted on an arm of the bracket C, and is held in position by a piece of spring wire, K, which, as shown, keeps B always in the same position. The rod H connected to the trigger B is connected to the crank G on the end of the counter-shaft. To this counter-shaft are fastened as many arms, I, as we have circuit breakers.



Automatic Circuit Breaker for Railway Circuits.

Now when any one, or all, of the circuit breakers, open, it moves the arm or arms I. These being fastened to the counter-shaft will turn it slightly, force the rod H down, release the cam A and allow the spring F to act on lever E and open the circuit. The diagram shows the position of the lever E when the switch is both open and closed.

The cut-out is operated by any one, or all, of the circuit-breakers; it could evidently easily be operated with either a solenoid or a horseshoe magnet. It could also be used on street cars and prevent the burning out of a fuse by pulling the switch.

By a very simple attachment of a cylinder and piston the movement of the lever could readily be applied to direct a blast of air against, and thus blow out, the arc from the switch points.

THE ELECTRICAL DETERMINATION OF "J."

A note has been received by the Paris Académie des Sciences from M. Constantin Miculesco on a new determination of the mechanical equivalent of heat. The principle of the method was the same as Joule's, viz., the production of heat in a calorimeter by means of friction. The whole of the work done by Joule's experiments, however, was small, and hence a good time was required to obtain a sensible heating of the calorimeter, and some difficult corrections had to be made. To prevent this, M. Miculesco used an electric motor to supply the work which was to be turned into heat. The apparatus comprised a 1 horse-power Gramme electric motor, carried on a frame suspended on knife edges, the motor-shaft being central with the line of these supports. On a separate frame was mounted a calorimeter consisting of two concentric cylinders, so that the axes of the cylinders coincided with the centre line of the motor shaft. By means of a flexible connection this shaft was coupled to one bearing paddles, which it caused to revolve in the water in the cylinders. Under such circumstances the frame carrying the motor tended to swing on its knife edges in oder to balance the torque on the motor shaft, and by correcting this tendency, by carefully adding weights, this torque could be measured with great accuracy. The result obtained was $J = 777.7$ foot-pounds.

THE LUGO SECONDARY BATTERY.

The loss of energy in secondary batteries due to chemical action when the battery is not in use, having always proved a fruitful source of trouble, Dr. Orazio Lugo, of this city, has devised a battery in which a neutral electrolyte is used which acts primarily upon neither element, but secondarily upon both.

The plates of the Lugo battery are of lead and zinc respectively, covered with lead oxide, and are separated one from another by an absorbent substance, such as blotting paper, and immersed in a bath of borate of ammonia.

The voltage and ampere capacity are claimed to be very high and the internal resistance low. The battery can be charged by very heavy currents and also discharged with a maximum ampereage without in the least injuring the plates as electrodes. The constancy is supposed to be due to the influence of the positive element on the active material in contact with it in preventing oxidation.

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VOL. XII. NEW YORK, SEPTEMBER 2, 1891. No. 174.

It is to our patent law—which has given to such knowledge a practical value in the hands of these men—that we are indebted for the possession of the most intelligent and skillful body of laboring men in the world.—Chauncey Smith.

PRIORITY IN ALTERNATING CURRENT MOTORS.

THE work which has already been performed by alternating motors and the much larger opportunity now opening up for them, have served to call attention to the value of the discovery of the rotating-field principle. As usual in such cases, a number of claimants for the honors of priority have appeared, but the dispute, so far as the fundamental principle is concerned, is limited to Prof. Ferraris and Mr. Tesla. We cannot believe that any one who has thoroughly examined the record of the work done, and published, can for one moment be in doubt as to whom the credit of having first made the discovery belongs. But that there are some who are still of doubtful mind is evident from statements that have been put forth in electrical journals, especially in Europe.

Without wishing to prolong a controversy that has probably had its origin in the fact that Mr. Tesla has obtained patents based on this discovery, we deem it a duty to correct the erroneous impressions due to lack of thorough knowledge of all the work done in this country. When even so impartial and well-informed a man as M. Hospitalier, whose otherwise excellent résumé of alternating-current motors appeared in our last issue, does not credit Mr. Tesla with that which is but his, we feel constrained to lay before our readers the simple facts as we know them.

Prof. Ferraris has been credited with the discovery now in controversy, on the strength of his admirable paper read before an Italian scientific society in March, 1888, and published in Italian shortly afterwards. But, five months before this, in October, 1887, Mr. Tesla had already filed applications for patents embodying the discovery, and several months again before that time had so far perfected his invention that a company had been formed to exploit it. Many prominent persons, including several electricians, then saw the Tesla motors at work; and during the winter of 1887-8 one of the best known scientific men in this country examined and reported favorably upon them. Some time in April one of the present editors of THE ELECTRICAL ENGINEER, knowing of this new work, saw the motors which had then been running for some time in a temporary laboratory, and induced Mr. Tesla to bring his discovery before the May annual meeting of the American Institute of Electrical Engineers. The Secretary of the Institute assisted at these negotiations, and as a result the motors were actually shown, before a large gathering in this city.

On May 1, 1888—the same year—patents were issued to Mr. Tesla in this country as the result of his applications in October, and were then accessible at once in every European country. But the work of Prof. Ferraris was not brought to light in English-speaking countries, and others, too, for that matter, until it was first given prominence by the publication of it in the May 18, 1888, issue of *Industries*. That interesting article was freely copied here and abroad, as it well deserved, and its publication in this wise created the false idea that Prof. Ferraris' striking work was simultaneous with that of Mr. Tesla, or even prior. But the description of the Tesla invention must evidently have been made public in the patent, in England and other countries, before the date of the *Industries'* article; and, besides the issuance of the patents, there is the fact that our contemporary, the New York *Electrical Review*, had given a short illustrated description of the Tesla motors on May 12.

More than this. In his essay of March, 1888, Prof. Ferraris expressly denied the practicability of motors that Mr. Tesla already had in successful operation! He hinted at the possibility of using a proper generator for such motors, but no further did he go. Mr. Tesla had already taken coal out of the mine before Prof. Ferraris made his geological survey of the region. With this admission from Prof. Ferraris, it was not very likely that practical men would recognize the great value of the new principle.

On examination of Mr. Tesla's now familiar work, we find that he, on the contrary, had not stopped short at a mere rotating field, but dealt broadly with the shifting of the resultant attraction of the magnets; that he had evolved the multiphase system; that he had shown the broad idea of motors employing currents of differing phase in the armature with direct currents in the field; that he first described and used an armature with a body of iron and closed coils symmetrically wound; that he had shown both synchronizing and torque motors; that he had shown how machines of ordinary construction might be adapted to his system, and had with specific purpose advanced boldly into new territory of which there was not the slightest hint or suggestion in the work of Prof. Ferraris.

In other words, Mr. Tesla not only went to the bottom of the fundamental principles, but tried them in every detail that inventive ingenuity could hit upon. If this is not so, it is time to have the contrary state of affairs proved before Mr. Tesla loses the credit that such work must give him.

THE FRANKFORT-LAUFFEN LONG-DISTANCE POWER TRANSMISSION.

The work which has now been in course of construction for several months, both on the generators and motors, as well as the line between Lauffen-on-the-Neckar and Frankfort-on-the-Main, has now been practically completed, and we are in receipt of a cablegram from our Frankfort correspondent, under date of August 26, informing us that at the preliminary trial made on that day 100 h. p. was successfully transmitted.

The distance between generator and motor is 112 miles, and a pressure of 30,000 volts is employed. The generator used in this installation was described in our last issue, and, as will be recalled, is of the 3-phase type. The current from the generator is transformed upward by a step-up transformer, the secondary of which is connected to the line, and at Frankfort a step-down transformer furnishes current to a set of so-called "rotary-phase" transformers, designed by Von Dolivo-Dobrowolsky for the Allgemeine Elektricitäts-Gesellschaft, of Berlin, who are carrying out this work in connection with the Oerlikon Works, of Zurich, Switzerland, of which Mr. C. E. L. Brown is the electrical engineer. The results already obtained leave little room for doubt that the enterprise will prove a complete success.

THE INCANDESCENT LAMP SITUATION.

In The Electrical Engineer of July 29, some observations were made in reference to the commercial situation in the incandescent lamp business, as affected by the decision of Judge Wallace sustaining the Edison patent. The case has now gone to the new appellate court, and a final determination of the matter may therefore be looked for within a few months at farthest. Whether the decision of the circuit court be sustained or reversed, is, of course, a matter vitally affecting the interests of the now somewhat numerous lamp manufacturers of the United States. The position of the defendants in the particular case decided, as the remarks of the judge at the time of granting the stay of proceedings unmistakably indicate, is materially stronger than that of other manufacturers, and moreover, the United States Company has many valuable patents of its own on lamps, details and processes of manufacture, dating back to the very beginning of the industry. In consideration of these facts, and especially in view of the remarks of Judge Wallace at the time of granting the stay of proceedings, it would seem obvious that if by any possible means an adjustment of the matter could be brought about by the parties in conflict, it would be an eminently wise, not to say profitable, procedure. Such a course, it will be remembered, was many years since pursued in connection with the sewing-machine patents, all of which were necessarily subject to the Howe patent of the eye-pointed needle. The various manufacturers in the combination, each of which was able to contribute valuable patents to the making of a successful machine, were permitted to go on, paying a royalty to the owners of the Howe patent on each machine turned out. The result was that the several concerns became so well established in their business, that even to this day, with all the patents expired, it has been found a practical impossibility for any new concern to get a foothold in the business, while the profits of the original syndicate can only be computed by millions, no small share of which would otherwise have found its way into the pockets of the legal fraternity. In the incandescent lamp industry, such a policy would at least have the effect of suppressing irresponsible manufacturers, as well as of maintaining a high standard of quality in the product, a consummation which could not but inure to the direct and permanent benefit of the consumer.

UNIPOLAR DYNAMOS.

There is, perhaps, no better known fact in electrical science than that first demonstrated by Faraday in the generation of current by the rotation of a conducting disc in a uniform magnetic field. The fundamental character of this experiment excites interest not only in the student, but in the experimenter, who still finds it a subject worthy of further research. That new and useful facts may still be gleaned in this field will be apparent on a perusal of Mr. Tesla's interesting Notes appearing on another page. The remarks bearing on Sir William Thomson's well-known "current accumulator" may be read with profit. A point of considerable practical value is that brought out in connection with the operation of alternating motors. It shows the great importance of observing the proper conditions in working such machines, which conditions involve the various elements of construction as well as the frequency employed. Mr. Tesla also points out some interesting methods for exciting dynamos.

LONG-DISTANCE POWER TRANSMISSION.

The comparison of efficiencies of various methods of transmitting power to a distance has long since demonstrated the superiority of electricity for the majority of cases occurring in practice, and involving the utilization of natural forces. But far more than any other method, the electric method permits of a wide range of conditions of working, and to select those which will result in the most economical operation has by no means always been an easy task in the past. In an elaborate discussion of this subject, Mr. H. Ward Leonard, in this issue, shows the relation to one another of the various factors which enter into the solution of a problem of this nature, and the results obtained by him, as exhibited in the charts, will, we are certain, be welcomed by every one interested in electric power transmission. Much of the discussion on this subject has been confined merely to a consideration of the cost of conductors. While this item is, no doubt, a large factor in the equation for economy, it is not by any means the only one, and it is therefore desirable, as pointed out by Mr. Leonard, to have a handy means of comparing all the factors without elaborate calculations.

THE NEW SHORT RAILWAY GENERATOR.

Among the pronounced developments of modern electrical engineering, and especially electric railway engineering, none has been more conspicuous than the ever-increasing size of power generators called for. We remember very well when a 75 h. p. generator was considered quite large for this class of work, but the demands of the present have already brought out 250 h. p. generators, and even these are now being exceeded by still larger ones.

As an instance of this we may cite the recent progress made in this direction by the Short Electric Railway Co., of Cleveland, Ohio, who are now prepared to furnish generators of no less than 500 h. p. Their new type of machines just brought out is illustrated in the accompanying engraving, which represents the 150 h. p. generator.

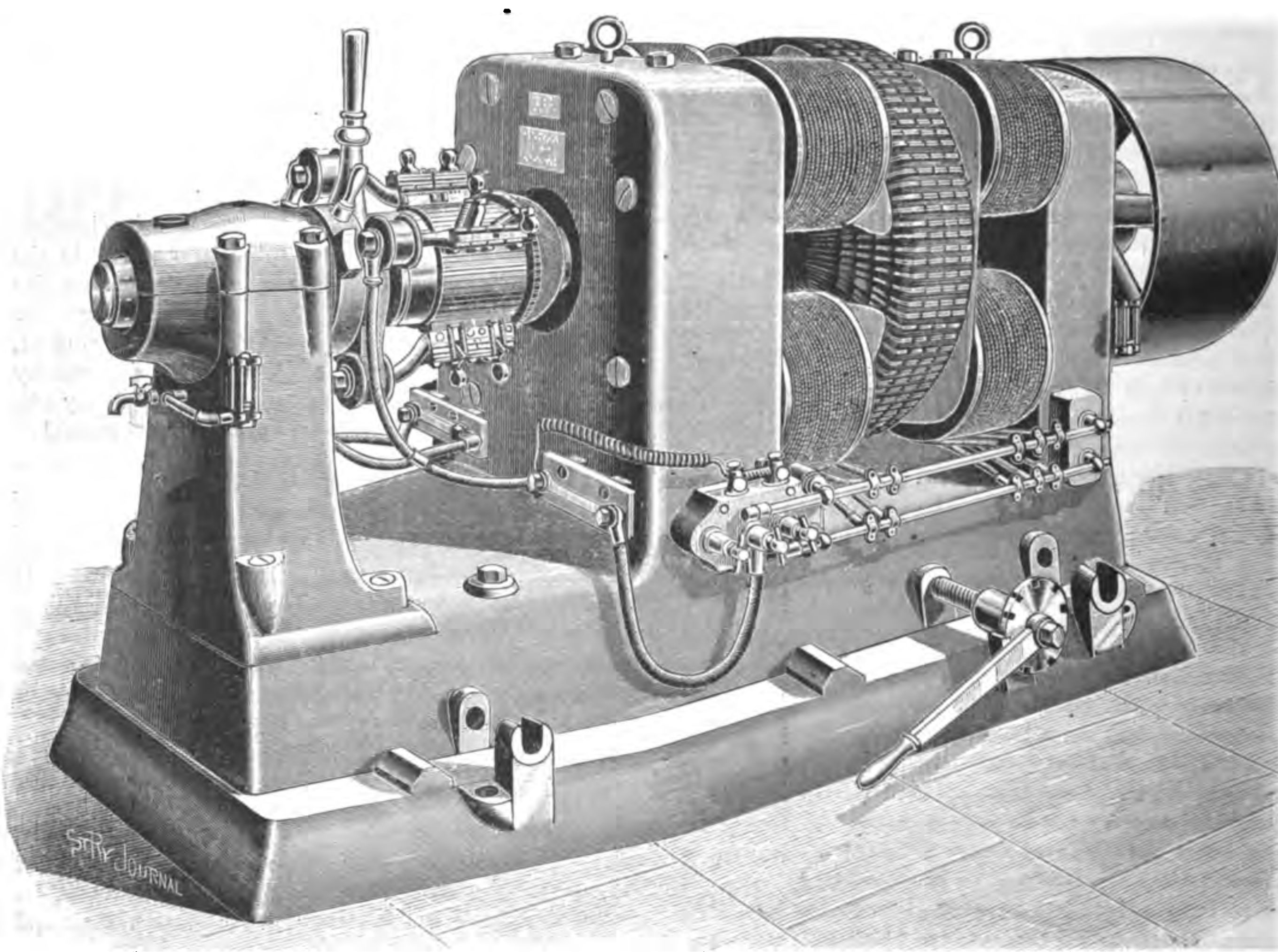
The illustration gives an excellent idea of the 150 h. p. generator, capable of delivering in continuous service 225 amperes at a pressure of 500 volts, equivalent to a total electrical output of 112,500 watts, and having, in fact, a reserve capacity above the normal of at least 30 per cent. in both current and voltage.

The great field-magnet frame is one of the largest and most perfect single castings ever made for electric work. It weighs over 8,000 pounds, and nothing but the softest and purest iron is used in the melting pots. It is annealed very slowly in the moulds, and when finished is so soft that it can easily be indented with a hammer. For properly finishing up the casting it was necessary to build a monster planing machine, one of the largest to be obtained.

To this heavy frame are bolted eight field magnets, carrying the shunt and series coils, and provided with pole-pieces of peculiar shape, arranged for side presentation to the armature, and so disposed as to make a powerful and almost perfectly uniform field of force within a narrow magnetic gap of large diameter.

Within this space revolves the armature, which is a distinctive feature of the machine. Its peculiar construction is well known to all who are familiar with the past practice of the Short company, which was the earliest, and for a long while the only, prominent advocate of what is known as the "Gramme Ring" construction for railway motors and dynamos now being generally introduced.

Upon a shaft nine feet long by six inches in diameter is keyed a massive spider carrying the foundation ring, upon which the armature is built up. The armature core is formed of thin sheet-iron wound spirally on the foundation ring and riveted firmly together. The outside circumference of the ring is somewhat wider than the remainder, and this portion is milled out into notches, forming a modified Pacinotti ring. The coils are then wound on the core around the hollow ring, the method being such that every one of the 200 coils is entirely exposed to the air on all sides, thus securing perfect ventilation. The projecting coils are, in fact, a sort of fan, and, in standing before the machine, the current of air set in motion by the armature can be detected ten or fifteen feet away. As a consequence, both armature and field run cool, and it is almost impossible to burn out a coil even with heavy overloads. Moreover, the destruction of a single coil does not



The New Short Railway Generator.

affect adjacent coils, and it is even possible, in case of necessity, to run the machine for several days without rewinding a burned-out coil. A burnt-out coil can be wound by any good mechanic at a cost of two or three dollars and a half day's labor. One of the most noteworthy features of the armature is its large diameter, viz., 36 inches, which is also, by the way, the diameter of the pulley usually employed with high-speed engines. The centre of gravity is low and the machine runs smoothly and quietly.

The details of construction are carefully worked out. The armature shaft runs in large self-centering and self-oiling bearings, the lubrication being accomplished by rings carried by the shaft and drawing oil from a reservoir in the usual way. The height of the oil is indicated by the little sight glass on each box. At the commutator box is also found an adjustable ball-bearing thrust collar containing several hundred balls, and so arranged as to carry the armature thrust in either direction without the slightest heating. This is an entirely novel feature in this class of machinery.

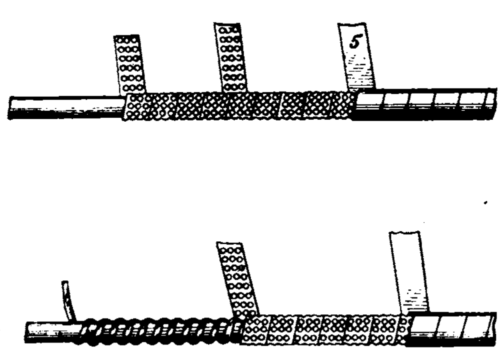
The commutator is carefully built and unusually large in diameter, viz., 20 inches. It has 200 bars, so that the pressure between the adjacent bars is very small and the sparking nil. The brushes are four in number, and are carried by two independent collars and sets of brush holders. In order to secure perfect adjustment at the neutral points multiple carbon brushes are used. The terminals of the field coils are carried to two heavy bars held securely in place on each side of the base of the machine. The plan of connection is simple and in plain sight, and the machines are so exactly duplicates of each other that there is no necessity for other adjusting devices, beyond the ordinary field rheostat box. The dynamo is placed on a heavy foundation plate and moves on V-shaped rails by means of an ordinary ratchet and screw.

The electrical properties of the machine are quite as noteworthy as the mechanical. The magnets always work far below the saturation points, even at heavy overloads. The compounding has been so carefully calculated that the pressure curve is a straight line, passing from 500 volts at no load to 525 volts at full load, with speed maintained constant at 500 revolutions.

The Short company is building this type of generators in five sizes, viz., 75 h. p., 100 h. p., 150 h. p., 300 h. p., and 500 h. p. The last-named size will run at about 100 revolutions and will be connected direct to a vertical compound engine, thus doing away with all belts and shafting. It is probably that even larger sizes will be built later on, to accommodate the heavy railway work which is in immediate prospect.

THE DEGENHARDT ELECTRIC CONDUCTOR.

In order to decrease the static capacity of electric conductors, Mr. Frederick E. Degenhardt, of Chicago, has



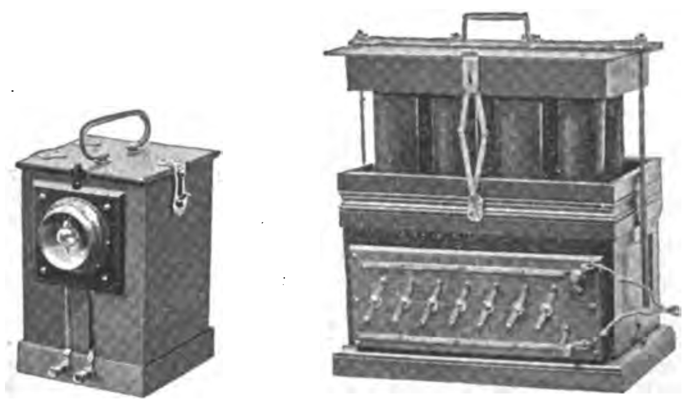
Figs. 1 and 2.—Degenhardt's Electric Conductor.

devised a system of porous insulation by means of which air or gas is retained between the conductor and the protective covering. As will be readily understood by reference to the accompanying illustrations, Figs. 1 and 2, a strip of perforated paper is wound about the wire either immediately, as in Fig. 1, or outside of a cord, as in Fig. 2. If the strip is comparatively thin, a second or even a third perforated winding is used. Over these is wound a solid strip whose edges overlap, and finally a non-conducting sealing material is applied.

When the conductors are made into cables, the solid strip about each is omitted. The wires covered with the perforated paper are twisted together, and wound with another perforated strip covering the whole, after which the covering of the cable is completed, as in the case of the single conductors, and a lead covering is added.

THE HUBBELL PORTABLE ELECTRIC LAMP AND BATTERY.

The accompanying illustrations, Figs. 1 and 2, show the lamp and battery manufactured by the Hubbell Portable



Figs. 1 and 2.—The Hubbell Portable Lamp and Battery.

Electric Lamp and Power Co., of 35 Broadway, this city. The type A, 4-cell battery lamp, Fig. 1, consists of a small battery 4½ inches square and 6 inches high, weighing, when fully charged, about 4 lbs., and capable of sustaining a standard 3 c. p. lamp for 10 hours at a cost of two cents for the entire time.

The-8 cell battery, type B, Fig. 2, is 12 x 6 x 7 inches, and when charged weighs 15 lbs. It is capable of running a 10 c. p. standard lamp for 10 hours at full incandescence, or a 12-inch fan or sewing machine for the same period of time at a cost of 5 cents for the entire period. Two batteries of this type coupled up in series will give 35 volts on open circuit and 10 amperes on short circuit.

It is the intention of this company, when the facilities for manufacturing are completed, to produce various other types for street-car lighting, wreckers' use, medical batteries for cautery purposes, carriage and cab lighting, propelling pleasure boats, isolated lighting, small batteries for stage and spectacular effects, and for bicycles.

NEW SWISS CABLE RAILWAY.

The water-power of Buochs, which is already used for working the Burgenstock Railway, is about to be employed in operating a cable line on the Stauserhorn. The water will actuate a turbine and dynamo, the current from the latter to be transmitted just over three miles to the three electric motors which will work the cable railway. The line will be nearly two miles long, and will be divided into three sections, each of which will be independent, and will be worked by a motor of 50 h. p.

Mr. Morton Edward Eden, of the Brush Electric Co., Cleveland, O., has been called to Europe to superintend some heavy electric railway construction in Spain, to be put in by an English concern.

ELECTRICAL SUBWAYS.[1]

BY ROSSITER W. RAYMOND.

THE final report of the Brooklyn Board of Commissioners of Electrical Subways, issued 2 years ago, still remains the best summary statement of the municipal problem with which it deals. In one noteworthy particular the opinion and prophecy of the board have received a striking confirmation. I refer to the matter of the corrosion of lead in conduits of creosoted wood. This evil was at one time very threatening, and so important that, although it constituted the only serious objection to the use of such wooden conduits, it might have counterbalanced, if the remedy had proved impracticable, all the great advantages of that material. One concern, at least, engaged in the manufacture of lead-covered cables, declined to guarantee them if laid in creosoted conduits.

The remedies suggested were two: The alloying of the lead with about 4 per cent. of tin—which, however, rendered the cables both more expensive and more difficult to manufacture—and the use of a fibrous covering, which was somewhat objectionable on other grounds. The Brooklyn board, however, caused careful laboratory tests and analyses to be made, and announced in its final report that, in its opinion, the corrosive agent is "phenol, which, being highly volatile, either escapes from the wood in the process of seasoning, or could be expelled more rapidly, if required, by artificial means." The frequent occurence of the phenomenon of corrosion in different cities was no doubt due to the haste with which underground conduits were everywhere constructed during that period of spasmodic reform under scientific legislation. Experience has proved that the Brooklyn board was right. The 2-year-old Brooklyn conduits do not now corrode lead—even pure lead—appreciably; and in some other cities where the authorities and electrical companies were almost ready, in a panic, to abandon the system, the simple lapse of time has cured the difficulty.

The underground system in Brooklyn seems to be running so peacefully and successfully that it is never heard of. If the Legislature had not summarily abandoned the whole experiment that city might now be a model in the extent, as it is confessed to be in the simplicity and perfection, of its subways. The present situation in Brooklyn is that there is no interference with the extension of overhead wires of all kinds, and no official control of their installation. In the final report of the late board an important list of all the electric light wires was given, with careful designation of every line where the insulation was dangerously defective. This list the Brooklyn newspapers did not reprint; nor have the city authorities, so far as I know, taken any action upon it. Meanwhile, by the lapse of later statutes, the old law of 1884, with certain amendments of 1885, has been left in force; overhead wires are prohibited; there is no authority anywhere to authorize or control their installations; and it is the duty of the municipal government to remove them—all of which is, of course, a dead letter.

As for the situation in New York City—who can tell what it is?

ELECTRICAL WORK IN MINES.[2]

BY ALBION T. SNELL.

AFTER calling attention to the growing use of electricity in mining operations in all parts of the world, Mr. Snell proceeded to describe a few of the more important plants now running successfully in Great Britain. The installation at the Newbridge Rhonda Colliery is, he continued, typical of the system in which use is made of over-compounded dynamos, and hence, is worthy of special notice. The problem here was to drive two pumps off the same set of mains. It was required to make the two pumps, 700 yards apart, independent, and it was also imperative that the electric light should be used at the pumping station, at the pit bank and pit bottom; and, further, there was to be only one dynamo. These conditions assumed that the pressure would be practically constant throughout the circuit. In practice, it is, of course, impossible to secure an absolutely constant pressure all over the system, owing to the resistance of the mains themselves; but by over-compounding the dynamo, so as to give a constant pressure at a point near the centre of the system, it is possible to approximate very closely to the required conditions. How well the case has been met is apparent from the fact that both the pumps can be switched off without appreciably raising the voltage of the lamps. The dynamo is of the Sh. D. C. $\frac{1}{1}\frac{3}{6}$ type, and running at 800 revolutions per minute gives a pressure of 300 volts and 60 amperes. Each of the motors gives 7 b. h. p., and runs at 800 revolutions per minute. The lamps are coupled in series of three. The pumps are three-throw rams, 4 in. in diameter by 9 in. stroke. The plant has been perfectly successful from the first.

An interesting application of the compound parallel system is the installation at Andrew's House Pit, Durham. The plant comprises a dynamo, three motors, cables, and three dip pumps. The pumps are respectively 1,500, 1,800, and 2,000 yards in bye; the one nearest the shaft is driven by a 4 h. p. motor; the others each work by motors of 2 h. p. The dynamo gives 250 volts and 40 amperes. The total capacity of the plant is thus small, but it is interesting on account of the distance between the pumps and the length of the cable. A few lamps are run at each of the pump stations, and also in the engine-house. The dynamo is arranged to compound for constant potential at about 1,500 yards in bye. Each of these motors has replaced a crank which required twelve horses for 24 hours work.

At the Standard Tin Company's St. Mauritius Mine, in Bohemia, the dynamo is placed below ground and is driven by a turbine, the water being led down a shaft by pipes. The motor is arranged to work a pair of lift pumps with spears 40 metres long, and also to wind ore through the same vertical distance. When the installation was first made the lower levels were drowned out, and the electric plant had to pump them dry before work could be resumed. This was successfully accomplished in a shorter time than the engineers expected, and ore is now being regularly raised by the plant. The power of the motor is about 20 horse. At Eger, at one of the brown coal mines the main ventilation is produced by a fan driven by electricity. The dynamo is driven by a turbine about half a mile away from the fan house, and the current is carried by bare wires mounted on poles with fluid insulators. The power of the motor is approximately 25 horse. The fan has now been running for about 12 months, and the manager reports that it is working perfectly satisfactorily.

Other examples might be given, but the preceding cases are fairly representative of the work now being done.

Mr Snell then referred to the risks attending electrical installations in mines, the first of these being the danger from shocks, and stated that, as no casualty from this cause has been reported from any mine in England, in one of which a working pressure of 700 volts has been used for three years, this risk may be considered practically negligible.

The second risk is that from fire, which may occur from the ignition of gas by the sparking of the brushes, or the burning of timber through faulty insulation. Marsh gas and air explode at about 1,000 deg. C. (1,832 deg. F.), according to the mixture. It would appear that although under normal conditions there would be little danger of a motor igniting gas, yet, if by any means the brushes and commutator became heated beyond a certain intermediate point, this danger would arise; and if motors are to be used in fiery mines it will be necessary to protect them by enclosing the entire armature and commutator in a dust-tight metal box sufficiently strong to resist the force of the explosion of possible gas within it, or to box in the commutator and brushes only. The former method has the advantage of also guarding against sparks caused by a possible short circuit on the armature. The second method does not protect the armature winding at all, but it reduces to a minimum the volume of gas which may be exploded by sparks.

1 *Engineering and Mining Journal*, August 8, 1891.

2. Abstract of paper read at the annual meeting of the South Wales Institute of Engineers.

THE PROPAGATION OF ELECTRIC DISTURBANCES ALONG CONDUCTING WIRES.

IN *La Lumière Électrique* of August 8th, Prof. Hertz offers some remarks on a contribution to that journal by M. J. Blondin, which appeared in its issue of July 18th. M. Blondin opened his article with the following remarks: "According to Maxwell, an electric disturbance should be propagated along an insulated conducting wire with the same speed as through the dielectric medium surrounding it. To show that this is so would, therefore, constitute an invaluable verification of the truth of the theories of the English *savant*. The determination of the speed of propagation of electric waves in metallic wires has been of late the subject of much work, the most important of which has been described in this journal (*La Lumière Électrique*). Unfortunately, the contradictory results arrived at, so far from confirming the theory of Maxwell, seemed to show that it could not be applied without modification to propagation along conductors, and it is only quite recently that the question has been definitely settled in a sense favorable to Maxwell's ideas by the work of MM. Sarasin and de la Rive. I therefore think it useful to take up the systematic study of the propagation of periodic electric disturbance along a conducting wire."

To this systematic study Prof. Hertz replies as follows: "M. Blondin treats in an extremely just and kind manner certain errors which, it seems, have crept into my researches. I have scarcely anything to add to the very clear explanation of M. Blondin, and I am only desirous of taking this opportunity of myself stating in this journal that the conclusions which M. Blondin arrives at are in perfect accord with my present conviction, although they disagree with the results of the experiments which I published a few years ago. When I began these experiments I was inclined to think that they ought to furnish two identical speeds, and I was astonished and disappointed to find that experiment gave unequal speeds. On this account I am fairly confident that I did not carry out my experiments with preconceived ideas, and in repeating them at the same place and under the same conditions I over and over again obtained the results published in my Papers. This does not preclude the idea that local conditions, either unknown or badly interpreted, had a disastrous influence, and falsified the results. To see if this were so, I endeavored to repeat the reflection experiments in my present amphitheatre, which is a fine room, 17 metres long, 12 metres broad, and five metres high, without iron pillars to interfere with the experiments. I was, therefore, hopeful of obtaining excellent results and certain success. Unfortunately, the benches, which I was unable to remove, were ranged one above another in tiers in such a manner that I was obliged to give to the waves a somewhat inclined direction, unsymmetrical with regard to the horizon and the walls of the room. Under these conditions for waves several metres in length the experiment succeeded very badly. The interference phenomena were much less pronounced than I had usually found them; the nodes were so ill-defined that their true position remained doubtful to within more than a metre. Once again, therefore, I was obliged to give up the idea of personally experimentally verifying the facts.

"Nevertheless, these experiments enabled me to ascertain how great may be the influence of local conditions on long waves in a room of moderate dimensions and not completely empty. I even think that any such closed space complicates vibrations and produces effects analogous to acoustic vibrations in cubic tubes; that is to say, tubes the dimensions of which are approximately all the same. If this is so, the intensity of the disturbance and its distribution in space will depend in a large measure on the relation which exists between the period of the exciter and the period of the vibrations proper to the closed space, on the position of the exciter relative to the nodal surface of the simple vibrations, &c., &c.

"Perhaps we shall find in these considerations a possible explanation of the diverse results obtained; in any case I do not publish them as a proven explanation. However, it does not seem to me that the beautiful experiments of MM. Sarasin and de la Rive were carried out under better conditions than were my own. If any physicist has at his disposal a large gallery, eight metres high and eight metres broad, and from 20 to 40 metres long, I think that even now it would not be lost labor to repeat these experiments on a large scale in order to remove the last uncertainty from science. I do not doubt that such an experiment would verify the results of the Geneva physicists. In a laboratory of ordinary dimensions I think it would be very difficult to get a certainty greater than that already obtained."

CONTRIBUTIONS TO THE THEORY OF SECONDARY CELLS.[1]

BY F. STREINTZ.

This paper considers the capacity and efficiency of elements with positive plates of various sizes. For the experiments E. P. S. plates, supplied by Messrs. Getz and Odendall, of Vienna, were sawed up so that the cut passed through the middle of the lead framework. The active material was thus not interfered with. Three elements were tested: In I., the positive plate contained 5x5 meshes of the lead network; in II., 5x6; and in III., 6x6; the distances between the elements in each case were 1.5 cm. In a larger vessel was placed an amalgamated zinc plate in dilute sulphuric acid; by means of a glass syphon this could be put into communication with the contents of each of the three elements, for the purpose of determining the potential difference between the zinc and the plates of the accumulators.

The experiments were conducted as follows: The element was first charged by a known current for several hours beyond the point at which the negative plate began to give off hydrogen. It was then discharged with the same resistance in the conductors until the current strength fell 10 per cent. below its stationary value. This discharge, during which the potential and current strength were taken every hour, served to determine the capacity. On the following day it was again charged at the same current, but this time the charging was stopped as soon as hydrogen began to be given off; finally came a discharge under similar conditions, following usually immediately upon the charge. The observations taken during the second charge and discharge served to determine the efficiency.

The tests showed that the capacity, *i. e.*, the number of watt hours which an element was capable of giving out before the current strength fell 10 per. cent., increases as the current strength diminishes. The element II. showed the highest capacity of the three. It was demonstrated that a reduction in the size of the positive plate conduces to an increase in the capacity, the efficiency at the same time not being lowered.

[1] *Wied. Ann*, Vol. XLIII.

WHY TELEGRAPH WIRES ARE UNDERGROUND IN CHINA.

The following is not without interest:

"A superstitious reverence for the dead accomplished years ago in China something that regard for the comfort and safety of the living, even when aided by judicial mandates and radical municipal methods, has been only partially able to accomplish in this country," said a telegraph lineman who was in the employ of the company that established the first telegraph line in China.

"The telegraph wires are placed underground there, and if the company had not so disposed of them there would have been no telegraph lines in China to this day. Dead ancestors are held in peculiar reverence in that curious country, and the casting of a shadow upon the grave of an ancestor is looked upon by the Chinese as an insult not to be borne, and it is always resented with impetuous rage. Now there are no cemeteries or general burying grounds in China, but every family's ancestors, particularly in the rural districts, are buried on the family premises. Consequently, every yard or garden is a receptacle of ancestral remains, and as China is thickly populated, the revered bones of dead and gone Mongolian progenitors may be found resting beneath every few rods of earth. When the telegraph company went to work to put up the poles on which to hang its wires the workmen were embarrassed every little while by wrathful Chinamen, who would rush angrily upon certain poles and chop them to the ground, and warn the workmen with much furious chatter that they would put them up again at their peril. The cause of this interference was unknown to the workmen, who were at last forced to discontinue the work, and explanation was demanded by the authorities. Then it was learned that the poles that were cut down had cast a shadow some time during the day on the graves of revered ancestors of Chinamen, and the insult could be wiped out in no other way but by summarily removing the poles. It was found that this superstition was too sacred a one among the Chinese to be overcome by persuasion or bribery, and at last the telegraph company, as a matter of economy and self protection, laid their wires beneath the surface, where they have been ever since."

SEARCH LIGHTS IN THE NAVAL MANŒUVRES.

Many years' experience of search lights in naval sham fights, says *The London Times* correspondent, convinces me that these machines, which in certain circumstances are invaluable, are too often so utilized as to be of far more assistance to the attack than to the defence. When an ironclad, believing that torpedo boats are near her, but seeing none of them, begins flashing her search lights in order to discover the enemy, she greatly helps her foe, who thenceforward knows exactly where and how she lies, and to what quarter her uneasy suspicions are directed. By all means cover the mouth of your anchorage with permanent and steady beams of light, so that any craft entering must cross the beams and so reveal herself; but do not let these beams proceed from battleships, or, indeed, from big ships of any sort. They should be thrown only from small craft and from boats, or, still better, from points on shore. The only time, in my humble opinion, when a threatened battleship should use her light is when she has already clearly discovered an approaching enemy. Then let her flash it full into his eyes. It will blind and puzzle him, and, falling on his hull, guns and paintwork, it will give her a capital target for gun fire. Splendid, when thus used, was the effect of the light upon torpedo boat No. 25, in Luce Bay, on the morning of July 27th. From the moment when the beam struck the boat she was as good as destroyed, for she stood out so clearly that only very bad gunners could have missed her. The light ought not to be worked from any point very near the guns which are to be fired. The ideal position is as far as possible below them. It is, all things considered, a mistake to mount lights on bridges and chart-houses; they cannot be too close to the surface of the water.

CRYSTAL PALACE ELECTRICAL EXHIBITION.

We are informed that the directors of the Crystal Palace, in deference to the wish of the Electrical Trade Section of the London Chamber of Commerce, have finally decided to postpone the opening of the Electrical Exhibition from November, 1891, till January 1, 1892, on which date the exhibition will be formally opened. The following are a few of the gentlemen who have consented to act as an Honorary Council of Advice: Prof. W. Grylls Adams, Prof. W. E. Ayrton, Mr. H. R. Beeton, Mr. Shelford Bidwell, Major Cardew, Sir Daniel Cooper, Bart., Mr. J. I. Courtenay, Prof. W. Crookes, Mr. W. B. Esson, Mr. S. Z. de Ferranti, Mr. J. E. H. Gordon, Mr. E. Graves, Mr. J. H. Greathead, Mr. R. Hammond, Dr. Hopkinson, Prof. D. E. Hughes, Mr. Gisbert Kapp, Prof. A. B. W. Kennedy, Mr. A. E. Mavor, Mr. W. M. Mordey, Mr. W. H. Preece, Prof. Henry Robinson, Sir David Salomons, Bart., Mr. Alexander Siemens, Prof. W. C. Unwin, and Major-General C. E. Webber.

Literature.

LEGISLATION RELATING TO COMPANIES THAT OPERATE UNDER MUNICIPAL FRANCHISES.

ONE of the most important publications affecting electric light and electric railway interests is that about to be issued by Robert Clarke & Co., of Cincinnati. It is entitled "Economic Legislation of all States Relating to Incorporated Companies Operating under Municipal Franchises," and is the production of Allen R. Foote and Charles E. Everett, the latter being a member of the Cincinnati bar. In the preparation of the work these gentlemen have had the assistance of a competent attorney in each State. The prospectus gives a list of them, making it clear that the highest legal ability has been secured; many of the names being already associated with literary legal work. The book will be in two divisions, the first, by Mr. Foote, a discussion of the economic principles involved in this legislation; and the second, by Mr. Everett, comprising all the economic legislation in question. The second division will embrace an introductory chapter of an analytical nature, tracing out differences and similarities in the laws of various States; then the State sections written by resident attorneys, and lastly a concordance index. All the sources of information will be drawn upon, particularly the State constitutions, legislative enactments, judicial decisions and municipal ordinances. In the State sections, the subject will subdivide itself into Historical, Franchise Companies, Franchises, and Municipal Ownership.

The value of this most important work will be found in its accuracy, completeness and arrangement. Every citation will be fully and clearly made, and each of the authors has been impressed with the idea that it is a good rule never to spoil a meaning to save a word. Such a work is indispensable to members of legislatures and municipal councils, officers and stockholders of companies, investors, jurists and economists, editors, and the public generally, and is likely, we think, to find also a great many readers abroad, where the course of American social and economic legislation is very closely watched.

It must be evident to all that the preparation of such a work, extending over two years, and representing so much expert ability, must be very costly. Mr. Foote, however, has placed the price of the book at only $10 per copy, and hopes that it will reach a sale of, say, 5,000 copies, recouping the outlay that has been risked on it, and preparing the way for other desirable efforts in the same field. Questions of municipal ownership are daily more and more discussed, and the agitation is very largely based on misconception of the facts. Such a book as this is timely and is likely to be one of the determining factors in the greatest politico-economic movement of modern years. Subscriptions should be forwarded to Mr. Foote, P. O. Box 482, Washington, D. C.

Dynamo Construction. By John W. Urquhart. New York: *D. Van Nostrand Co.*, 1891. 113 illus., 352 pages. 7½ x 5. Price, $3. Cloth.

THIS is a work of a thoroughly practical nature. It contains little history, and not overmuch of theory, but forms a most useful manual of the mechanics of the dynamo. The various questions relative to the framework, winding of field magnets and armatures, compounding, dimensions of cores, characteristic curves, and the like, are treated in detail, and with much clearness as well as with accuracy. Chapter 18 is very practical indeed, dealing as it does with a number of points in the erection of dynamos, and their operation under the conditions of station and plant work. We note, by the way, at the end of Chapter 17, a statement that with the Brush and Thomson-Houston machines at least, or even more than, 50 arc lights can be run in a single circuit. This is true, but far below the mark, for with the new Excelsior machine, and, unless we are mistaken, with the new Wood machine, the number goes over 100. It may be said that this requires a dangerous potential, but we cannot see any difference in that respect between 2,500 volts and 5,000, while the latter limit offers many additional advantages.

It is possible that the author might have said more about motors and the special principles of their design, whether for stationary or traction work. What is said is good, but some of it is antiquated, and far behind the date of American practice. But taken generally, the book is a very creditable addition to electrical literature, and will find many readers.

Wire: Its Manufacture and Uses. By J. Bucknall Smith, C. E. New York: *John Wiley & Sons*, 1891. Cloth. Illus., 347 pages. 11 x 7. Price, $3.

MR. SMITH is entitled to thanks for this very interesting and valuable contribution, to which he has evidently given a very large amount of time and thought. While in every way a technical treatise, it is full not only of data as to processes, but embodies a large quantity of useful and even amusing notes on the many uses to which wire is or has been put. Mr. Smith has traveled extensively in the practice of his profession, and seems at every step to have found something that would be worthy of adding to his collection of matter on this subject. Chapters 1 and 2 deal with the different kinds of wire, *i. e.*, iron, steel, copper, platinum, &c.; and the 3d relates to gauges. Chapter 4 is of special interest to electrical engineers, being devoted to electrical conductors. It is true that only bare, or uninsulated, wires are spoken of, but otherwise the chapter is complete; and it contains moreover some good tables of resistances, weights, strains, &c.

The book is divided into two sections, and Chapter 4 begins the second with a very full account of the various uses of wire ropes. This part includes cable cars, rope haulage, &c., and abounds in data that the electrical engineer very often is in need of in the discussion of the relative merits of electricity and the cable, &c. Then comes a chapter devoted to wire netting and woven fabrics and one on wire fencing.

There is a careful index to the book, with a full synopsis also of the contents of each chapter and a list of the illustrations. It is to be regretted, therefore, that the cuts in each chapter are numbered separately. The book is well bound and printed, and, as we have said, is unusually interesting.

Reports of Companies.

AMERICAN BELL TELEPHONE CO.

THE instrument account of the Bell Telephone Company shows:

Month to Aug. 20.	1891.	1890.	Increase.
Gross output	5,773	4,322	1,451
Returned	4,309	2,761	1,548
Net	1,464	1,561	*97
Since Dec. 20.	**1890–91.**	**1889–90.**	**Increase.**
Gross output	48,396	42,686	5,710
Returned	27,708	17,752	9,956
Net	20,688	24,934	*4,246

The instruments now in use amount to 504,478.

SECOND AVENUE RAILWAY, PITTSBURGH.

DURING the year ending June 30, 1891, the Second Avenue Passenger Railway Company, of Pittsburgh, operating the Thomson-Houston and Westinghouse electric systems, carried 1,808,993 passengers, according to its report recently filed at Harrisburg, and but twelve persons were injured, the accident, however, having been due to the carelessness or inattention on the part of the injured persons. The receipts of the road for the year were $88,-492.45, and the expenses, $61,094.94.

WEST END RAILWAY FIGURES FOR JULY.

THE July figures of the operation of the West End Street Railway Company have been compiled by the auditor, and are published herewith:

	Total.	Electric.	Horse.
Gross receipts	$554.431	$144,552	$409,878
General expenses	27,718	6,955	20,657
Track and car expenses	179,853	43,891	135,954
Motive power	142,670	26,398	116,271
Total operating expenses	350,137	77,239	272,888
Net earnings	204,294	67,303	136,990
Miles run	1,497,468	377.191	1,120,377
Ratio mileage	100.00	25.19	74.81
Per cent. operating expenses	63.15	53.44	66 58
Earnings per mile run	37.02	38.32	36.58
Expenses per mile run motive power	09.53	07.00	10.38
Car repairs	00.75	01.17	00.61
Damages	06.07	00.12	00.06
Conductors and drivers	07.71	06.92	08.23
Other expenses	05.12	05.37	05.07
Total ex. per mile run	23.38	20.48	24.35
Net earnings per mile run	13.64	17.84	12.23

The report for July shows a decrease of $7,965 in net earnings as compared with June, but an increase of $88,359 over April, and $38,770 over May. June is the banner month in the street railways of Boston, and it is expected that net earnings will gradually decrease from June figures until such time at least as the increase of electric lines brings about a decrease in operating expenses. Operating expenses for July were 63.15 per cent. for the system as it stands to-day, and while this is in contrast with 61.37 per cent. for June, the company can pay ten per cent. upon its present common stock with operating expenses at seventy per cent. The real point of West End earnings is to be found in the electric lines expense account. As the new power houses of the West End come into operation the result is seen in the reduced cost of motive power. In April and May the motive power for a horse car cost 10.86 cents per mile, while in June and July it could not be gotten lower than 10.38 cents. The motive power for an electric car has been brought down to seven cents per car mile, and will be lower in future. President Whitney is keeping his expenses per electric car mile very close to twenty cents, and a year hence they should be a good deal lower.

Society and Club Notes.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

THE Committee on Transportation, finding that, owing to the inability of the West Shore R. R. Co. to make suitable connections on the return trip, making a change of trains necessary, have deemed it advisable to change the route.

A special train will leave the Grand Central Station, at 42d street, at 9.10 A. M., Sunday September 6th, arriving in Montreal at about 9.35 P. M.

Fare from New York, round trip, to Montreal......$12.00
" " " " " " (cert. plan) 13.33
" " " to Montreal, one way......... 10.00
Extra, each way, for parlor car accommodations... 2.00

Delegates from the South and West desiring to take this train should purchase through tickets *via* N. Y. C. & H. R. R. and Central Vermont R. R.

For the convenience of the New York delegates, to avoid the rush at the station, railroad tickets and information can be obtained at the Electric Club, 17 East 22d street, New York City, on Saturday, September 5th, from 3 to 5 P. M.

The excursion tickets will be good to return until the 20th of September. Railroad tickets and parlor car accommodations can be secured at the office of the N. Y. C. & H. R. R. R. Co., 413 Broadway, New York City. For further information, address C. O. Baker, Jr., chairman, New York, care National Electric Light Association, 136 Liberty street, New York City.

College Notes.

UNIVERSITY OF NEBRASKA.

MR. R. B. OWENS, of Greenwich, Conn., has just been appointed Professor of Electrical Engineering at the University of Nebraska, Lincoln, Neb. It is an adjunct professorship, being within the jurisdiction of Prof. D. B. Brace, who is in charge of the Department of Physics; and the course extends over two years. Mr. Owens is a young man, but has already made an enviable record. He began his studies at Johns Hopkins, and afterwards became connected with the Baxter Motor Co., of Baltimore, and the Excelsior Co., of New York. He was then put in charge of the Thomson-Houston station at Greenwich, Conn., which he constructed and operated; and while thus actively engaged he took the post-graduate course in electrical engineering under Prof. Crocker at Columbia College, receiving his E.E. degree this summer. He will assume his new duties at the fall term, and is already busy in making a judicious expenditure of $15,000 in equipment of apparatus and instruments. The plant will include a 500 light alternating outfit and one of 500 lights direct, with a 100 h. p. tandem engine. Representing as he does the best training of the East, as a graduate of Johns Hopkins and Columbia, and being acquainted with the practical side of the electrical engineer's profession, Prof. Owens starts out well equipped for his new work. We look for excellent results from Lincoln.

Obituary.

LOUIS H. SPELLIER.

LOUIS H. SPELLIER, the inventor of a time telegraph clock and of several improvements in the transmission of time by electricity, died at his home, No. 219 North Sixteenth street, Philadelphia, on Saturday, Aug. 22d, in his 48th year. Mr. Spellier was a member of the Franklin Institute and was an authority on electrical matters. He will be remembered by many electricians throughout the country on account of the active part he took in promoting the success of the International Electrical Exhibition at Philadelphia in 1884.

FREDERICK ROBINSON.

WE regret to announce the sudden death of Mr. Frederick Robinson, who is well known in the electrical trade as a dealer in slate specialties for electrical work. He was found dead in his bed on August 20.

"THE AMERICAN MANUFACTURER AND IRON WORLD," of Pittsburgh, J. D. Weeks, editor, has recently made a decided improvement by adopting the quarto shape, ENGINEER size, and by conforming its typographical dress thereto. In its new form it will be more valuable and useful to its readers than ever.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSTED AUGUST 18, 1891.

Accumulators:—

Plate for Secondary Batteries, A. F. Madden, 457,880. Filed Jan. 2, 1891.
For keeping the electrodes separated, employs a plate having separator-plugs molded therein with a shank extending through the plate and heads on each side.

Conductors, Conduits and Insulators:—

Method of Insulating Electric Conductors, Thomas E. Morford, 457,828. Filed Dec. 26, 1890.
Relates especially to the insulation of conductors in electric heating devices such as sad-irons, cooking utensils, etc.

Joint for Electric Conductors, George T. Manson, 457,865. Filed April 1, 1891.
Relates to the protection of joints, with especial regard to the exclusion of moisture from the joint. Employs an elastic tube surrounding the insulation of the conductors on both sides of the joint, and clamping devices to compress the elastic tube into water-tight engagement with the insulation.

Dynamos and Motors:—

Electromotor-Engine, Sebastian Ziani de Ferranti, 457, 875. Filed Sept. 24 1888.
A motor adapted to be driven by alternating currents, and designed especially to facilitate starting from a state of rest. Employs an auxiliary synchronizing-motor coupled with a non-synchronizing motor.

Electric Motor, Charles J. Kintner, 457,902. Filed June 14, 1890.
Claim 1 follows:—
The method of diminishing friction between the rotary and fixed parts of an electric motor consisting in causing the magnetism developed in the field magnets, and the work done by the motor to act conjointly against the force of gravity on the rotary part, and to thereby hold it off its lower end journal-bearing, substantially as described.

Lamps and Appurtenances:—

Illuminator for Electric Lamps, John von der Kammer, 457,830. Filed Jan. 10, 1891.
Makes a filament of a quantity of cellular threads which have been cleansed and subjected to a slightly destructive action of acid; they are then immersed in a paste of ground shoe-blacking, dried and heated.

Electric Arc Lamp, Elihu Thomson, 458,025. Filed April 27, 1891.
Directed to securing a refined and positive feeding motion and to compactness and moderate length in the lamp itself.

Metal Working:—

Method of Electric Bending and Straightening, E. Thomson, No. 458,115. Filed May 21, 1886.
Brings the section or part of a bar, or other piece to be operated upon, to a working heat by passing a heavy electric current through it by means of suitable clamps.

Miscellaneous:

Electric Stop Mechanism, Washington H. Kilbourn, 457,838. Filed Dec. 24, 1890.
Electro-magnetic device for stopping machinery; particularly adapted for automatically closing a valve.

Electric Door-Opener, Richard J. Ward, 457,906. Filed Sept. 15, 1890.

Railways and Appliances:—

Closed Conduit System for Electrical Propulsion, William B. Heron, 457,778. Filed March 27, 1891.
Claim 1 follows:—In a closed conduit system, the combination of a conduit, a traveling armature in said conduit, a wheeled vehicle, a motor and a magnet on said vehicle, a source of electrical energy leading to the motor to operate it, and an auxiliary source of electrical energy leading to the magnet to energize it to attract the armature, substantially as described.

Electric Car Truck, Thomas Tripp, 457,802. Filed April 17, 1891.
Claim 1 follows:—In an electric truck, the axles provided with loose geared wheels, each wheel being provided with the roller-carrying ring, to which are secured the roll-carrying pins and the sets of rolls which are located between the wheel-hub and the axle, and the thrust-plate mechanism consisting of the thrust-plate, which is secured to the wheel and in operation, rotates between the thrust-plate collars, which are firmly fastened to the axle, substantially as set forth.

Electric Railway Appliance, Frederick E. Degenhardt, 457,836. Filed Oct. 13, 1890.
Relates particularly to devices for conducting current through a fixed concealed conductor to the moving car.
Claim 1 follows:—The combination of an electrical conductor with a series of chambers through which it successively passes, said chambers made air-tight by a fluid seal and contactors disposed along such conductors and adapted to engage the same within such chambers when depressed, and an exterior contact surface connected with such contactors and adapted to be engaged by a conductor connected with a moving motor.

Railway Signal, L. F. Munger, 457,855. Filed Jan. 15, 1891.
Electro-magnetic semaphore system.

Electric Railway System, Milton Shoemaker, 457,870. Filed Nov. 3, 1890.
Employs underground conductors. "Object is to provide a system for operating cars by means of electricity without the use of poles, overhead wires, or any wires whatever, except the one through which the current of electricity is conducted."

Electric Railway System, Samuel E. Wheatley and John W. Schlosser, 457,944. Filed April 15, 1891.
Employs sectional working conductors, and relates specially to devices for contact between the sectional conductors, a continuous conductor, and a motor.

Electric Wire Crossing, Charles H. McKee, 458,063. Filed Jan. 26, 1891.
For electric railway junctions.

Telegraphs:—

Automatic Telegraph, David Kunhardt, 457,816. Filed Sept. 23, 1890.
A system of automatic transmission, employing sectional contact wheels and an elaborate system of circuits.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED AUGUST 25, 1891.

Accumulators :—

Secondary Battery, O. Lugo, 458,424. Filed May 26, 1891.
Designed to preclude chemical action when the battery is not in use. Consists of a relatively positive metal, such as zinc, and a relatively negative metal, such as lead, placed in a solution of borate of ammonia, which will not act primarily upon either electrode, but will act secondarily upon both.

Secondary Battery, O. Lugo, 458,425. Filed May 26, 1891. See p. 281, this issue.
Similar to the next above with the addition that both electrodes are coated with a suitable oxide.

Clocks :—

Electric Alarm-Clock, C. Lester, 458,178. Filed April 10, 1891.

Electric Alarm-Clock, L. Winterhalder, 458,206. Filed Dec. 4, 1890.

Electric Alarm-Clock, J. O. Newton, 458,372. Filed May 25, 1891.

Conductors, Conduits and Insulators :—

Electric Conductor, F. E. Degenhardt, 458,316. Filed Sept. 1, 1890.
Winds a conductor spirally with a cord and superposes a strip or strips provided with air-filled perforations.

Insulating Compounds, J. L. Marmaud, 458,551. Filed May 19, 1891.
Consists of calcined lixiviated infusorial earth, talc or soap-stone, lamp-black, sulphur, litharge, rosin, silicate of soda, rubber, bi-sulphide of carbon, fir-balsam and benzine or naphtha.

Dynamos and Motors :—

Electric Motor, L. Gutmann, 458,162. Filed Dec. 1, 1888.
For alternating currents. Invention consists in passing an alternating current through the field coils of a motor (with subdivided or laminated cores) and short-circuiting a part of the armature coils.

Method of Operating Alternating Electric Motors, L. Gutmann, 458,164. Filed Feb. 4, 1890.
See The Electrical Engineer, August 26, 1891, page 230

Armature for Dynamo-Electric Machines, L. A. McCarthy, 458,236. Filed Feb. 18, 1891.
Has cores projecting radially from its periphery and wound in the manner of an electromagnet.

Ignition :—

Automatic Gas-Lighting Apparatus, G. D. Clarke, 458,154. Filed Dec. 30, 1890.
Adapted for the lighting and extinguishing of gas jets at predetermined intervals of time ; employs clockwork.

Electric Gas Lighter, H. A. Pinkham, 458,486. Filed Oct. 25, 1890.

Lamps and Appurtenances :—

Electric-Lamp Socket, H. E. Swift, 458,242. Filed March 23, 1891.

Portable Electric Lamp, L. Bristol, 458,279. Filed Aug. 28, 1890.
Includes a closed secondary battery.

Arc-Lamp Electrode, W. S. Richards, 458,376. Filed Jan. 8, 1891.
Carbon has a capillary conductor of refractory material extending along its exterior.

Electric Arc Lamp, N. M. Garland, 458,386. Filed Dec. 29, 1890.
Aims to prolong the life of the carbons ; employs a movable protecting cap or hood of refractory material surrounding the carbon rod near its coned end, together with a metallic sleeve connected to the frame of the lamp by good conductors of heat ; the hood and metal sleeve adapted to move with the carbon as the latter is consumed.

Electric-Arc Lamp, N. M. Garland, 458,387. Filed Dec. 29, 1890.

Electric-Arc Lamp, N. M. Garland, 458,388. Filed Dec. 29, 1890.

Electric-Arc Lamp, N. M. Garland, 458,389. Filed May 18, 1891.
The three patents above are for improvements in amplification of the invention shown in No. 458,386 above.

Electric-Arc Lamp, H. W. Sander, 458,500. Filed May 4, 1891.
Employs carbon rods made in the form of an arc of a circle.

Medical and Surgical :—

Electric Uterine Supporter, G. F. Mohn, 458,536. Filed Mar. 26, 1891.

Metal Working:

Art of Electric Welding, H. Lemp, 458,176. Filed May 31, 1890.
Intended to secure improved contact between the clamps and the article to be welded. Employs a continuous layer or film of liquid between the clamps and the piece or pieces to be worked, thus excluding air.

Adjustable Electric Clamp, H. Lemp, 458,177. Filed Oct. 9, 1890.
For use in electric welding.

Electric Clamp, E. Rasmussen, 458,188. Filed Dec. 19, 1890.
For use in electric welding ; employs a yielding material of good conductivity between the clamps and work pieces.

Miscellaneous :—

Alternating Electric Current Heater, L. Gutmann, 458,163. Filed Dec. 9, 1889.
See The Electrical Engineer, August 26, 1891, p. 226.

Electric Coal-Mining Machine, E. C. Morgan, 458,184. Filed Sept. 15, 1890.
Employs an electric motor, a tubular tool-holder, and a spring partially enclosed by the tool-holder and interposed between it and the frame.

Electric Stop Mechanism, E. Boening, 458,278. Filed July 24, 1890.

Circuit Closer, P. D. Richards, 458,343. Filed Mar. 30, 1891.

Cut-Out, W. F. Irish, 458,396. Filed Sept. 15, 1890.

Railways and Appliances :—

Insulator, M. C. Chase, 458,221. Filed Nov. 14, 1890.
Specially adapted for supporting trolley wires.

Electric Power-Brake, C. V. Greenamyer, 458,242. Filed Dec. 2, 1890.
Specially adapted for use on railway cars as an emergency brake.

Motor Apparatus for Vehicles, R. J. Sheehy, 458,274. Filed Nov. 24, 1890.
Includes devices for storing the mechanical energy of the motor when it is not employed in driving the car, and means for applying such stored energy to assist in starting.

System of Electrical Propulsion for Vehicles, W. S. Richards, 458,377. Filed Jan. 19, 1891.
An induction system, avoiding the necessity for contact with the line conductor.

Support for Trolley-Wires, J. H. Palmer, 458,427. Filed Dec. 19, 1890.

Electric Signal and Switch-Moving Mechanism, J. Ramsey, Jr., E. W. Harden, C. M. Wilder, 458,489. Filed Feb. 5, 1891.
Electromagnetic devices for operating a switch rail, a signal or a gate.

Electric Motor, C. E. Egan, 458,545. Filed Nov. 28, 1890.
This patent is not for an electric motor, but is for devices for the application of batteries upon electric motor cars.

Telephones and Apparatus:—

Spring Jack Commutator for Telephone Switchboards, L. A. Berthon, 458,258. Filed Jan. 30, 1891.

Telephone, E. Noriega, 458,479. Filed Feb. 4, 1891.
In a telephone receiver employs a U-shaped magnet and two electromagnets facing the diaphragm.

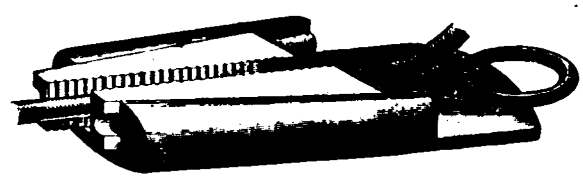
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The best "Come-Along" for holding trade is a good "Ad."

THE COPE AUTOMATIC "COME-ALONG."

We herein give an illustration of a device for holding or gripping electric and other wires and cables, invented by T. J. Cope, No. 8 North 6th street, Philadelphia. The most prominent claim for this "Come-Along" is that it does not break the insulation, but the simplicity of the tool and its self-acting, both in gripping



The Cope Automatic "Come-Along."

and releasing are features of merit. It consists of two parallel jaws, slightly corrugated on the inner sides and working loosely in two stationary supporting jaws in such a manner that when the wire or cable is placed between the loose parallel jaws and drawn, the jars are closed from mere contact to sufficient pressure to hold the cable or wire. It will be seen that there is no more pressure on the insulation or wire than is necessary to hold the same, and the direct pull and long jaws prevent twist or kink in the wire or breaking of the insulation, and is easily released by merely reversing the pressure on the tool.

ELECTRIC MINE HOISTS.

The Pleasant Valley Coal Company, of Salt Lake City, Utah, have for the past year at the Castle Gate Mine, in Utah, used a hoist or haulage drum, operated by electricity. The drum was made by the Lidgerwood Manufacturing Company, of New York, and the electric motor and the electrical equipment were furnished by the Thomson-Van Depoele Electric Mining Co., together with all the electrical apparatus for the power station.

Trains of sixteen large pit cars run out of the mine by gravity, dragging the tail rope after them. The empty trains are hauled back into the mine by the haulage drum located nearly 2,000 feet from the chute in the interior of the mine. The operation of this apparatus has proved so satisfactory and so economical that the company have ordered two more electric hoists of more powerful type.

In every way the electrical apparatus has been so satisfactory that for the Winter Quarters Mine, operated by the same company, they have ordered an electric locomotive and the equipment of nearly two miles of underground railway with the Thomson-Van Depoele system.

ENGINEERING EQUIPMENT CO.

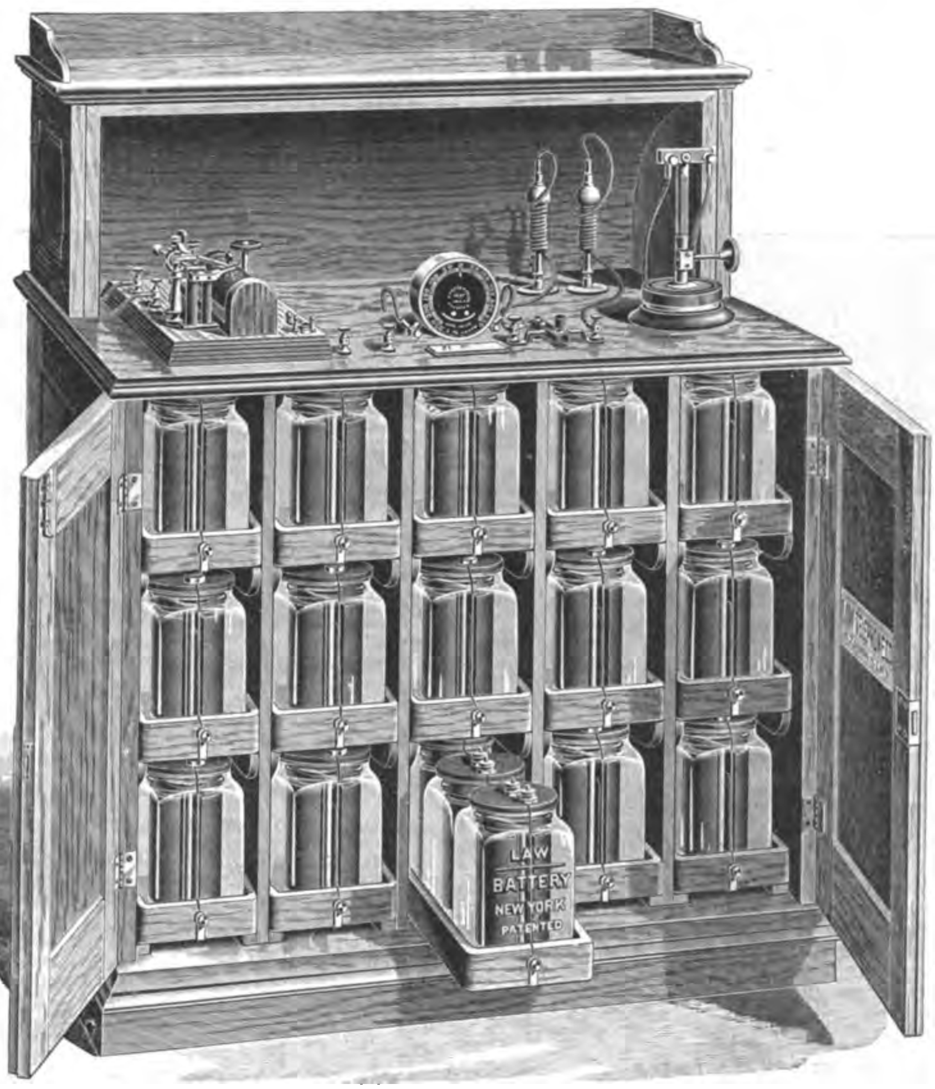
Among recent shipments made by the Engineering Equipment Co., general Eastern agents for the Boston trolley and Anderson's line materials, have been complete trolleys delivered at New York, McKeesport, Schenectady, Scranton, Buffalo, Chicago and Denver, Colo., together with poles, wheels, and other parts at Portland, Ore.; Ridgeland, Ill.; Colorado Springs, Butte City, Mont.; Pottsfield, Pa., Long Island City, McKeesport, Connellsville, Buffalo, Augusta, Ga., Dallas, Texas, and other places.

THE LAW ELECTRO-THERAPEUTICAL OFFICE OUTFIT.

THE accompanying illustration represents the new battery cabinet manufactured by the Law Telephone Co., of 85 John street, this city, for the use of physicians. On the left is seen the faradic coil; in the centre is the milliammeter, and close beside it, the pole-changing switch. On the right is the current regulator or controller. The two binding-posts at the right of the milliammeter are for use only with the galvanic current, and those at the left with the faradic, and are so marked.

The drawers in which the batteries are placed are arranged to hold four cells each, the connections from which are made through strips of metal on the bottom of the drawers to strips of metal on the slides, and the apparatus will not work unless the cells are correctly placed in the drawers and the drawers in the cabinet. The current from the zinc of the battery is led through a Bailey current-regulator to the polarity-switch, and the current from the carbon of the battery is led to the polarity-switch and thence to the milliammeter. The throwing of the polarity-switch changes the direction of the current, and the handle or knob of the polarity-switch indicates by its position which binding-post is positive.

The outfit is arranged with one red and one green cord for connecting the electrodes, thus permitting the physician to readily trace the positive current by means of the handle of the switch and the cord to the patient.



THE LAW ELECTRO-THERAPEUTICAL CABINET.

UNDERWOOD COTTON-LEATHER BELTING.

THE recent business on the Underwood cotton-leather belting shows a marked improvement over any previous record. The long list of large belts which is shown by the Engineering Equipment Company, the selling agents, gives strong proof of the large volume of business done lately in this excellent belting. Among the orders for large belts are the following: Willimantic Linen Co., seven belts; Schuyler Electric Co., Middletown, Conn.; Buffalo Street Ry. Co., several belts; Springfield, Mass., Electric Light and Power Co., one 66-inch belt, 128 feet long, and several others; Newark, N. J., Passenger Ry. Co., two belts; Fort Orange Paper Co., 38-inch and 40-inch belts; also many others in the United States and foreign countries. Besides this class of trade in the larger belts there has been a lively demand for smaller sizes of cotton-leather. All this speaks well for the growing reputation of the belting made by the Underwood Manufacturing Co. It is probably generally known that the first leather belt made in this country was manufactured by Henry Underwood. The Engineering Equipment Company, contractors for steam and electrical equipment materials, represent the Underwood interests at 143 Liberty street, New York, and 126 Pearl street, Boston.

THE CORLISS STEAM ENGINE CO.

THE above company, of Providence, R. I., have favored us with a framed albertype picture of their latest improved Corliss engine of the single cylinder type. It is a very handsome piece of work, and makes a neat ornament for an office. The engine itself is a model of strength and beauty.

NATIONAL TELEPHONE MANUFACTURING CO.

AT the annual meeting of the stockholders of the National Telephone Manufacturing Company, held at Portsmouth, N. H., the following board of directors were elected: S. K. Roberts, Woodward Emery, L. B. Russell, James D. Leatherbee and John B. Bennet. The report of the treasurer showed that the company could pay all of its indebtedness with a handsome surplus, besides holding nearly 10,000 shares of stock in the treasury.

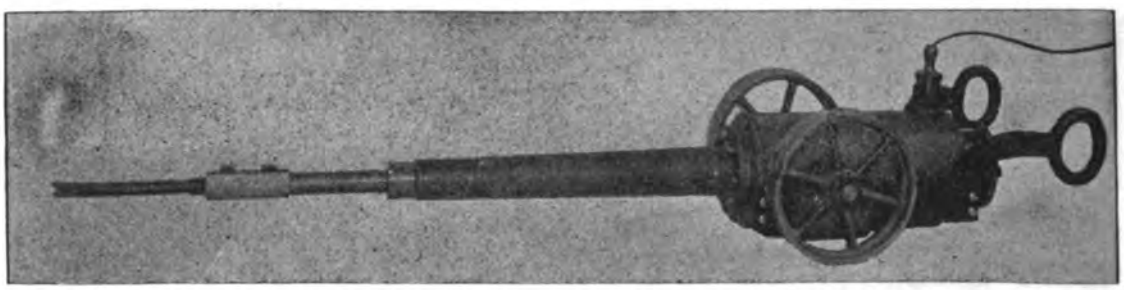
THE VAN DEPOELE SOLENOID COAL CUTTER.

IN some grades of coal it is found desirable to make the under cut with a machine concentrating its power upon a single reciprocating shaft, carrying a chisel at its extremity. This type of cutter or drill is very compact and is controlled by one man, the direction of the blow being varied as occasion demands. Several machines of this type, operated by steam or compressed air, are on the market, and are in many ways satisfactory, but the application of electricity as the motive power possesses many decided advantages.

The illustration shows the Van Depoele solenoid coal cutter, manufactured by the Thomson-Van Depoele Electric Mining Co., of Boston. The type shown is the present standard form, though modifications can be made to suit special requirements. The operation of the cutter may be easily understood from an inspection of the illustration, and no extended explanation is required. The direction of the blow is determined by the operator, who sits on the floor facing the breast, his feet resting against the wheels, and his hands grasping the handles at the rear of the cylinder, thus obtaining a double leverage, by which the machine, being almost exactly balanced, is easily turned on its points of support.

A simple switching device turns the current on or off, as desired, while lights, pumping apparatus, electric ventilators, etc., may be run on the same system of wires which supply power to the coal cutter, if desired.

The weight of the apparatus is a little over 700 pounds, the number of strokes usually from 300 to 350 per minute, although the rapidity of the blow can be varied at pleasure. The stroke is from five to six and one-half inches. The tension guide is made in different lengths, according to the depth of undercut desired.



VAN DEPOELE SOLENOID COAL CUTTER.

THE MONTREAL CONVENTION.

ALL the arrangements have now been perfected for the convention, and there is every prospect of a most successful meeting. In view of the misery that has often been experienced by delegates through the poorness of the hotel accommodations, it is some satisfaction to know that this time the Association has the advantage of enjoying as its headquarters a hotel of such well-deserved reputation as the Windsor. It is not often that so large a gathering of Americans is seen at a Canadian hotel, and the management is on its mettle to show that the Windsor cannot be surpassed, if equalled, even in the United States, in studying the comfort and welfare of its guests and in lavishly providing for every want of the traveler.

NEW ENGLAND TRADE NOTES.

BEACON VACUUM PUMP AND ELECTRICAL COMPANY.—Mr. Heilborn, of this company, is still in Europe, and reports that the Beacon Vacuum Pump is attracting much attention among the European manufacturers of incandescent lamps. Several of these companies are now negotiating with him for the use of the pump for lamp purposes, and Mr. Heilborn has been requested to prolong his visit for the purpose of consummating some arrangement with them. The European lamp companies have already had numbers of samples of lamps exhausted by the Beacon pump, and state that they are as good as, if not better than, they require. The Beacon Pump Company are diligently at work on a meter, the invention of Mr. William Edson, which will soon be ready to put on the market. It has been fully tested and pronounced a success.

S. C. NIGHTINGALE & CHILDS, of Boston, New England agents for the magnesia sectional covering, report that they have just received orders to cover with plastic magnesia the 27 engine cylinders, the nine air-pump cylinders, 18 receivers, and nine sets of connecting pipes between the cylinder and the receivers, of the nine large triple-expansion engines now being set in place by E. P. Allis & Company, of Milwaukee, for the West End Street Railway Company, of Boston. The steam cylinders will be coated with magnesia, 1¼ inches thick, the receivers 1¼ inches thick, and the piping one inch thick. Magnesia is surely coming forward as the most reliable protection against radiation of heat.

WHITMAN & ROBINSON have now got comfortably settled down in convenient quarters at No. 133 Essex street, Boston, and have got a very complete laboratory of electrical instruments for all kinds of electrical testing and calibrating. They have already expended a large sum of money on these instruments, and when the laboratory is completed they will be well equipped for making the most elaborate tests. They have recently made a specialty of acting as consulting electricians for cities looking toward municipal lighting, and have just completed an elaborate set of tests on the arc lights of the city of Haverhill for the city authorities.

THE EDISON GENERAL ELECTRIC COMPANY, through their Boston office, have closed a contract with the town of Waterville, Me., for a municipal plant of 100 arc lamps. They are also engaged installing a small central station at Charlton City, Mass., and are at present installing a very fine plant in the St. Paul School, at Concord, N. H.

THE HOLTZER-CABOT ELECTRIC COMPANY have now got thoroughly settled down in their new quarters at No. 92 Franklin street, and have fitted up a very handsome suite of offices and show-room on the second floor, measuring 80 feet by 40 feet. On the floor above they have another room of the same size, conveniently fitted out as a stock-room. Their business has been steadily increasing for the past year, and they will now be better able to handle it with promptness and care, as well as having pleasant offices for their patrons to visit.

MR. H. A. CLEVERLY, of Philadelphia, was in Boston this week calling on his numerous friends. He has been recruiting for a week or so after his arduous labors at "The" Clambake.

WESTERN TRADE NOTES.

OKONITE VS. KERITES.—The much-talked-of ball game between the Okonite Baseball Club, composed of employés of the Central Electric Company, and the Kerite Club, made up of the pick of the Western Electric Company, of this city, was played at Lincoln Park, Chicago, on the 15th ult., and resulted in a victory for the Okonites by a score of 11 to 7. The feature of the game was the invincible battery of Messrs. Cushing and Stacey. The Kerites played a very brilliant game, but did not seem to be able to "get on" to the tough curves and high-tension pitching of the Okonites.

THE W. D. GRAVES ELECTRICAL AND MANUFACTURING CO., manufacturers of the Graves Multiplex Arc Lamp, of Cleveland, O., have secured an order for two 15 h. p. C. & C. motors from the *Cleveland World* for operating their two large printing presses. These presses are capable of turning out 14,000 copies per hour. They have also installed another 15 h. p. motor in the Union Gospel News Co. for similar work.

THE ELECTRIC MERCHANDISE COMPANY, of Chicago, will be "at home" in parlors 14 and 16 Windsor Hotel, Montreal, during the convention, and will be represented by Messrs. D. B Dean and W. R. B. Wilcox. An exhibit of some specialties in line material will be made, and also some sets of the Burton Electric Heater will be shown in operation.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE

Electrical Engineer.

VOL. XII. SEPTEMBER 9, 1891. No. 175.

THE FRANKFORT INTERNATIONAL ELECTRICAL EXHIBITION—VII.

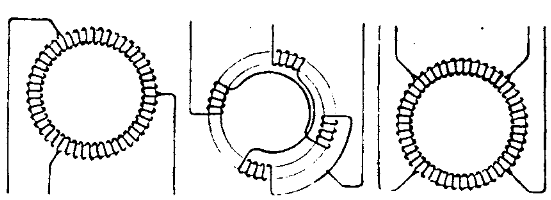
BY

Richard O. Heinrich.

The Multiphase Alternating Current.

TO all appearances the contracting parties for the Lauffen transmission will keep their word. At this writing the report comes that the line is completed and all the machinery in place. The 16th and 17th of August are to be devoted to experimental trials, and before this article has reached the other side the cable will have announced the fact, for which every electrician is looking with intense interest, whether this great scheme is a success or not.

The idea is rather a neat one, in which the perfect cycle of conversion of energy will be illustrated. The power is taken from the Neckar-Falls, at Lauffen, is converted into electrical energy, and is transmitted to Frankfort, where the electric motor is intended to drive a centrifugal pump. This pump will lift a steady stream of water to the top of a ledge of artificial rocks, being, as it were, a part of the original power, rushing down over a steep incline made of



FIGS. 1, 2 AND 3.

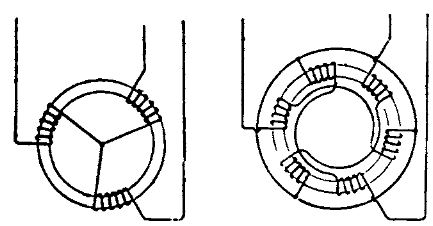
glass plates, illuminated from below from the same source of electrical energy.

It may be well to say a few words about the principle of this multiphase alternating current as applied to motors. Those who have read the articles of Mr. Tesla on his different types of alternating current motors will find old acquaintances in many respects. In fact, the subject is not at all a new one.

By way of explanation we will say that the coils on the armature of an alternating current machine are divided into a number of sections, so that between the coils of each section there exists separate electrical connection. The way in which this may be effected is shown in Figs. 1 to 5.

It is evident that we obtain as many successive current impulses as there are sections in the armature, as represented by the curves of Figs. 6 and 7. In the case of three sections the current wave II. is increasing when I. is decreasing, and III. is increasing from 0 to a maximum when II is decreasing and I. is attaining a negative maximum.

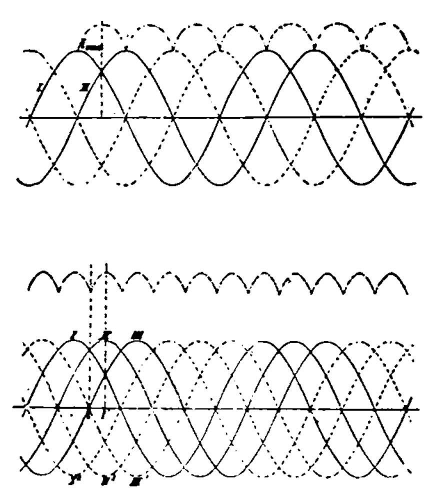
To use this three-phased current with a system of transformers it is only necessary to have three leads, if we arrange the primaries of the transformers as shown in diagram in Fig. 8. The primary of transformer A is traversed by currents over the leads III., II., from the first section of coils on the armature, B from the second section, and C from the third. The lead I. goes to the common junction of the primaries of transformers B and C. Wire III. is then the common lead for current impulses from the end of the first section of coils and the beginning of the second section; wire I. from end of second section and beginning of the third; and II. from end of third section and beginning of the first section. The same order prevails for the secondaries of the transformers.



FIGS. 4 AND 5.

If we follow the current impulses through the branches I., II., III., and 1, 2, 3, Fig. 8, and compare with Fig. 7, we shall find that in no part of the circuit do the current impulses act against each other. If we consider the magnetization in this three-part transformer, we find that, if the current increases in transformer A, the magnetization increases also; after having passed their maximum both current and magnetization decrease in transformer A, but increase in transformer B; finally the magnetization increases in C when that of B decreases and that of A attains a negative maximum. We may say that the magnetization travels from A over B to C and to A again, etc.

The same would be the case if we send this current into the armature of a machine similar to the generator. The polarity of this armature will continuously be changing in



FIGS. 6 AND 7.

a cycle around the armature and hence the name rotary current (Drehstrom), which was given to the arrangement by Herr von Dolivo-Dobrowolsky, of the Allgemeine Elektricitäts-Gesellschaft.

Herr von Dolivo-Dobrowolsky, however, makes claim to a distinction between his invention and that of Tesla, Ferraris, Haselwander, Bradley and others. Where only two or three phases are used, he speaks of an "elementary rotary current." In his own system more than three phases are used in general, so that his motors are driven by alternating currents of a very small difference of phase, using however only three leads for distribution. I shall describe the details of his system in the account of the Lauffen transmission.

In describing his invention, Herr von Dolivo-Dobrowolsky points out that the sum of the effects of a number of alternating currents displaced towards each other in their phases is not constant. Consequently the intensity of the magnetization is not constant, but more or less pulsating. He states, for example, that with two currents with a phase difference of 90° the pulsations amount to 40 per cent; with three currents of 60° phase difference, to about 14 per cent.; the magnitude of these pulsations decreases therefore very rapidly with the number of phases used. As long as the alternating current motor runs in synchronism, the effect of these pulsations is not injurious, but the efficiency of the motor is decreased considerably, if it does not run in synchronism. It is claimed as an advantage for the rotary alternate current motor that it runs with good efficiency without synchronism; in fact, they will always begin to rotate with considerable force as soon as the circuit is closed, and do not stop with suddenly increased load. But a pulsation of the magnetic field produces very strong induced currents in the field-winding of the motor, which is closed upon itself, and these induced currents have a retarding and braking effect and cause a loss of energy.

Three systems of multiphase alternating current are represented at the exhibition, namely, that of Schuckert & Co.,

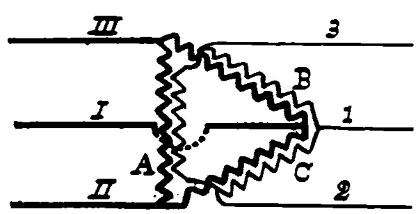


FIG. 8.

Nuremberg; Lahmeyer & Co., Frankfort (Haselwander patent); and the Allgemeine Elektricitäts-Gesellschaft, Berlin (Dolivo-Dobrowolsky).

Little information can be gained regarding the efficiency, advantage and disadvantage of the different systems, and it is to be hoped that the examining committee will throw some light on this subject. Under the circumstances I am only enabled to give a short description of the machinery used in the three systems, supplemented by some data supplied by the manufacturers.

The system of Schuckert & Co. would, strictly speaking, not come under the head of rotary current apparatus. The reason that I describe it in connection with the systems of this class, and take it up first, is that I consider Schuckert's system as a transition from the ordinary alternating current to multiphase alternating current.

The dynamo for the generation of the two-phase alternating current is identical in general appearance and construction with the continuous-current dynamo of that firm; the difference lies in the connection of the armature coils and the addition of four collector rings, shown on the left of the left-hand bearing of the machine, Fig 9. Fig. 10 illustrates the connection of the armature coils. The armature is a flat Gramme ring, and connections of the coils are made, as ordinarily, with corresponding commutator bars. Besides this, however, connections are made from four symmetrically situated points with the four collector rings, Figs. 10 and 11. In this respect the machine resembles a self-exciting alternating current machine, with the difference, however, that two alternating currents are obtained with a phase difference of 90°, represented by the curves of Fig. 12. In this way the efficiency of the machine as an alternating-current generator is greatly increased. If the continuous current machine were to be used as an alternating-current generator by omitting the commutator and substituting only two collector rings, the efficiency of this alternator would be about 30 per cent. less than it would be if used as a continuous-current machine. With this

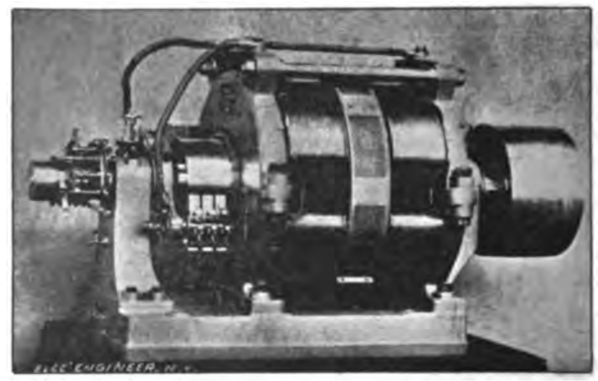
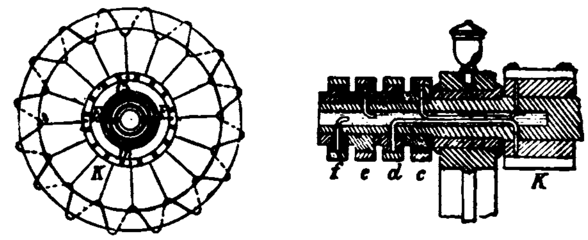


FIG. 9.—SCHUCKERT DYNAMO FOR MULTIPHASAL CURRENT.

combination of commutator and collector rings, nothing is changed in the machine; it may be used as a continuous-current machine, or it may deliver alternating currents for one or two circuits, and continuous current for a third one at the same time.

It is evident from what has been said before that we obtain an electric motor if we send this two-phase current into the armature of a machine similar to the generator. The armature of this machine, if fed with this two-phase current, will begin to rotate by means of the cyclic shifting of the magnetic polarity around the ring and the corresponding action of the iron of the field magnets, magnetized by induction. As soon, however, as the field magnets of the machine are excited by a continuous current and the motor runs synchronously a current is generated in this armature; in fact, it is a generator-motor, since it is immaterial whether the armature is rotated in a magnetic field by means of a belt and pulley or by means of a current. It is not necessary that the motor run in synchronism, although it will attempt to attain synchronism. If the field were to be excited with alternating current it would necessitate its being constructed of laminated iron,



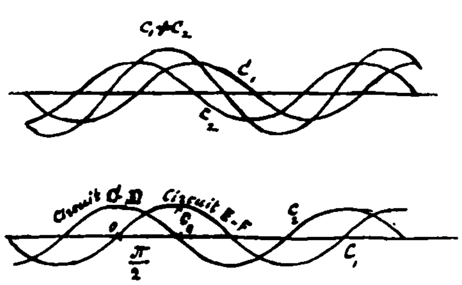
FIGS. 10 AND 11.—SCHUCKERT MULTIPHASAL ARMATURE AND COMMUTATOR.

and there would besides be a considerable loss of energy in the frequent change of magnetization. The field is, therefore, excited by continuous current, either from a separate source or directly from the commutator of the machine. This excitation, however, should only begin when the motor runs in synchronism. A very simple way of determining this point of synchronism is adopted by Schuckert & Co. As long as the motor runs without synchronism a current is induced in the field winding, since the magnetic circuit of the lines of force emanating from the armature takes place through the air or through the iron of the field magnets, corresponding to the respective position of the armature-polarity and the field magnets. Consequently, a voltmeter in the field-magnet circuit will show a large deflection as long as the motor is far from synchronism; this deflection decreases as the motor approaches synchronism and is zero with perfect synchronism. At this moment the brushes are placed on the commutator and the motor becomes self-exciting.

This construction gives a great flexibility to the system, and the machine may serve for the following purposes:

1. As a continuous-current machine. 2. As a self-exciting alternator, furnishing alternating currents of one phase or of two phases with 90° displacement. 3. As a continuous-current motor. 4. As an alternating-current motor. 5. As a transfomer of continuous current into alternating currents and *vice versa*. Using the machine as a continuous-alternating current transformer, the result will be as shown in Fig. 13. The current generated in the armature is displaced in its phase 45° towards the phases of the two primary alternating currents and its intensity will be $= c_1 + c_2$, and therefore 1.4 times as great as any one of the primary currents. The direction of rotation is determined by the position of the leads and may be changed at will, if the connections of one circuit are kept and the connections of the second circuit are interchanged.

Schuckert's system is exhibited in two places. One is the short transmission of 50 h. p. from a two-phase alternator in Machinery Hall to a synchronizing motor which drives the centrifugal pumps for the water-fall of the grotto. The field of this motor is separately excited, so that the motor is precisely like the generator, with only four collector rings, as shown in Fig. 14. Narrow double brushes are used on the collector rings, so that these rings may be made narrow. Since the distance of transmission is short, transformers are not used; without the use of transformers 4 leads are necessary for transmission. The generator makes 330 revolutions per minute, and furnishes for each of the two circuits 35 amperes at 550 volts pressure. The transmission from the "Palmengarten" ($\frac{3}{4}$ miles from the exhibition) to the exhibition is intended to illustrate a central power and light station in connection with long-distance distribution, for the special case where water power is available at some distance from a city. Generator and motor-transformer for this purpose are illustrated in Fig. 9. The generator is a self-exciting two-phase alternator, slow speed, running very smoothly and quietly; this is the case with all of Schuckert's machines, and is so marked that it requires close inspection to see whether the machine is running or not. From the four collector rings the current is taken at 80 volts pressure by



FIGS. 12 AND 13.

four leads to a step-up ring transformer, as described in THE ELECTRICAL ENGINEER, August 5, p. 133. The transmission to a step-down transformer at the distant station is made at 1,600 volts pressure, only three wires being necessary, the third wire serving as a common return for the two currents; it is also proposed to use only two cables and have the lead casing of the cables for the return circuit. Four leads go from the secondaries of the step-down transformer to the four collector rings of the motor generator, which runs in synchronism with the first generator. In the machine exhibited only continuous current is taken from the commutator of the motor generator, part being used to excite the field magnets, part to drive seven smaller continuous-current motors in the workshops of the exhibition and part for illuminating purposes. Alternating current of high and low voltage could also be used directly. As mentioned before, generator and motor run very noiselessly and the transformers do not hum. The flexibility of the system is well shown, so that it only remains to prove the efficiency of the transmission and transformation.

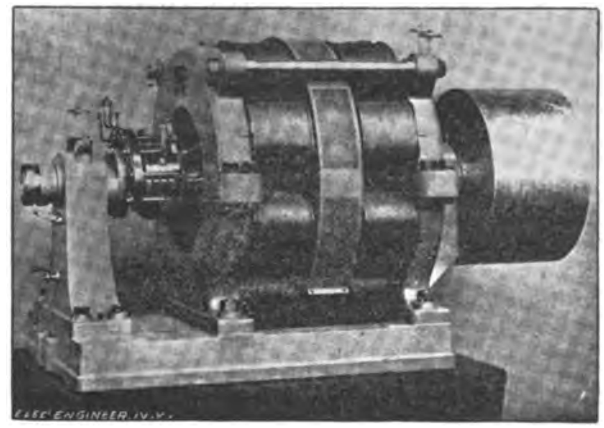


FIG. 14.—SCHUCKERT MULTIPHASAL CURRENT MOTOR.

THE LOCALIZATON AND REMEDY OF TROUBLES IN DYNAMOS OR MOTORS.—I.

(*Copyright.*)

BY

PROF. FRANCIS B. CROCKER

AND

DR S. S. WHEELER.

THE promptness and ease with which any accident or difficulty with electrical machinery may be dealt with, whether by the inspector of construction or by the operator in charge of running, will always have much to do with the success of the plant and of those dependent upon it. It is therefore likely that any method to eliminate or reduce these troubles would be very welcome to those handling dynamos and motors. With the object of obtaining such a method, we have prepared a list of troubles, symptoms and remedies, based upon quite an extensive experience with the various types and sizes of dynamos and motors in common use.

It is evident that this subject is somewhat complicated and difficult to handle in a general way, since so much depends upon the particular conditions in any given case, every one of which must be included in the table in such a way as to distinguish it from all others. Nevertheless, it is quite remarkable how much can be covered by a systematic and reasonably simple statement of the matter, and we feel confident that nearly all of the cases of trouble most likely to occur are covered by the table, and that the detection and remedy of the defect will result from a proper application of the rules given.

It frequently happens that a trifling oversight, such as allowing a wire to slip out of a binding-post, will cause as much annoyance and delay in the use of electrical machinery as the most serious accident. Other troubles, equally simple but not as easily detected, are of frequent occurrence. In such cases a very slight knowledge on the part of a man having the machine in charge, guided by a correct set of rules, will enable him to overcome the difficulty immediately and save much time, trouble and expense.

It must not be supposed that this method for treating dynamo and motor troubles is given because these machines are particularly liable to such difficulties. On the contrary, no machine in existence is mechanically simpler than the dynamo or motor. The only wearing parts about the machine, with the exception of the commutator and brushes, which are specially made to stand almost unlimited wear without interfering with the action of the machine, are the two bearings. In this respect, therefore, the dynamo or motor is as simple as an ordinary grindstone, and infinitely simpler than a steam engine, which often has a dozen or more oil cups and several dozen wearing parts. Even a sewing machine is far more complicated mechanically than any dynamo or motor. In fact, it would be useless to attempt to give a method for detecting and curing dynamo and motor troubles if it were not for the fact that these machines consist of very few parts, which makes it reasonably possible to locate the trouble.

The rules are made, as far as possible, self-explanatory, but a statement of the general plan followed and its most important features will facilitate the understanding and use of the table.

USE OF THE TABLE OF TROUBLES.

In the use of this table the principal object should always be to clearly separate the various causes and effects from each other. A careful and thorough examination should first be made, and as far as possible one should be perfectly sure of the facts, rather than attempt to guess what they are and jump at conclusions. Of course general precautions and preventative measures should be taken *before* any troubles occur, if possible, rather than wait until a difficulty has arisen. For example, see that machine is not overloaded or running at too high voltage, and make sure that the oil cups are not empty. Neglect and carelessness with any machine are usually and deservedly followed by accidents of some sort.

The general plan of the table is to divide all dynamo and motor troubles which are liable to occur into eight classes, the headings of which are the eight most important and obvious bad effects produced in these machines, viz :

No. 1. Sparking at Commutator.
No. 2. Heating of Armature.
No. 3. Heating of Field Magnets.
No. 4. Heating of Bearings.
No. 5. Noise.
No. 6. Speed abnormally high or low.
No. 7. Motor stops or fails to start.
No. 8. Dynamo fails to generate.

Any one of these general effects is very obvious, even to the casual observer, and still more so to any one making a careful examination, and every one of these effects is perfectly distinguishable from any of the others without the least difficulty. Hence, this classification is perfectly definite and makes it easy to tell, almost at the first glance, under which one of these heads any trouble belongs, thereby eliminating about seven-eighths of the possible cases. The next step is to find out which particular one of the six or eight cases in this class is responsible for the trouble. This, of course, requires more careful examination, but, nevertheless, can be done with comparative ease in most cases. Of course one cause may produce two effects, and, vice-versa, one effect may be produced by two causes ; but the table is arranged to cover this fact as far as possible. In a very complicated or difficult case it is well to read through the entire table and note what causes can possibly apply, and they will generally not be more than two or three, then proceed to pick out the particular one by following the directions which show how each case may be distinguished from any other. The table is intended for the use of those who build, test, install, own or operate electrical machinery, and all statements apply equally well to both dynamos and motors, unless otherwise specially noted.

SPARKING AT COMMUTATOR.

1. Cause.—*Armature carrying too much current*, due to (*a*) overload (for example, too many lamps fed by dynamo, or too much mechanical work done by constant potential motor); or (*b*) excessive voltage on a constant potential circuit or excessive amperes on a constant current circuit. In the case of a motor on a constant potential circuit, any friction, such as armature striking pole-pieces or shaft not turning freely, will, of course, have the same effect as overload in producing excessive current. The armature of a motor on a constant-current circuit does not tend to heat more when overloaded, because the current and the heat it produces in the armature (C^2R) are constant. In fact, armature can be stopped with full current without injury except loss of ventilation.

Symptom.—Whole armature becomes overheated and belt very tight on tension side and sometimes squeaks, due to slipping on pulley. Overload due to friction is detected by stopping machine and then turning it slowly by hand. See Heating of Bearings and Noise, No. 2.

REMEDY.—(*c*) Reduce the load; (*d*) decrease the size of driving pulley, or (*e*) increase the size of driven pulley; (*f*) decrease magnetic strength of the field in the case of a dynamo or increase it in the case of a motor. If excessive current cannot satisfactorily be overcome in any of the above ways it will probably be necessary to change the machine or its winding. Overload due to friction is eliminated as described under Heating of Bearings and Noise, No. 2.

2. Cause.—*Brushes not set at the neutral point.*

Symptom.—Sparking varied by shifting the brushes with rocker arm.

REMEDY.—Carefully shift brushes back and forth until sparking is reduced to a minimum. This may be done by simply moving the rocker-arm, provided the brushes are set so as to touch diametrically opposite points on the commutator. If the brushes are not exactly opposite they should be made so, the proper points of contact being determined by counting the commutator bars or measuring with a piece of string or paper.

THE ELECTRIC LIGHTING OF ODESSA HARBOR.

The Odessa Harbor electric lighting plant, constructed by the Thomson-Houston International Electric Company, was taken over on July 8 by the Russian Government. There are in regular working sixty-four 2,000 c. p. arc lamps and eight 125 c. p. incandescent lamps. The arc lamp-posts vary in height from 43 feet to 30 feet. There have been used about 10 miles of armored cable, manufactured by Felten and Guilleaume, and also about 1,000 yards of submarine cable 126 sq. mm. in cross-section, steel-wire armored. Where the submarine cable joins the land cable a Thomson-Rice cut-out is placed, allowing the cutting out of the submarine cable in case of fault. The generating plant consists of four 35-light series-wound arc dynamos, driven by belting from two central-valve condensing Willans & Robinson high-speed engines. The two boilers are supplied by the Babcock & Wilcox Company.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—XIV.

BY

Chas. Steinmetz.

IX. Magnetic Susceptibility and Saturation.

In the former chapters we have followed the phenomena going on in transformers, either when acted upon in the

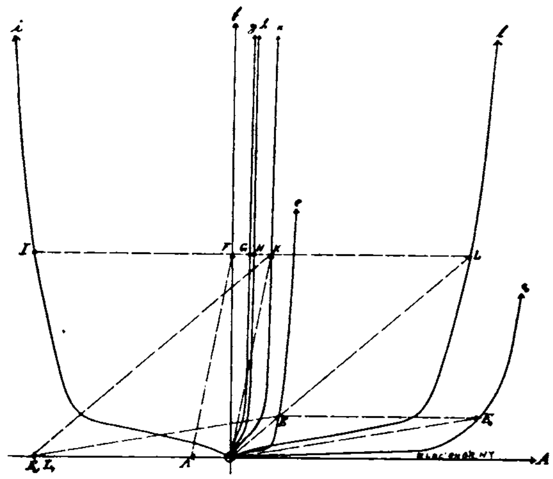


FIG. 27.

primary circuit by *constant potential*, or by *constant current*. We have determined the conditions, which must be fulfilled in a well-designed transformer, and have considered the *changes* which take place, when *one*, or a part, of its constants are changed, thereby showing its admirable ability of *compounding*, for *constant secondary* E. M. F. as well—when connected into a constant potential primary circuit—as for *constant secondary current*—in a circuit of constant effective strength of primary current.

We have shown the influence of *self-induction* and of *magnetic leakage*, and have also taken into consideration the phenomena caused by *eddy-currents*, and by *hysteresis*, and their representation in the *polar-diagram of alternate currents.*

But in all the former diagrams we still maintained one assumption, which, though it is for simplicity's sake nearly always made, nevertheless is very far from being true, as it holds only within narrow limits.

We have supposed that the induced E. M. F.'s, E_1 and E_1, are proportional to the resulting M. M. F., F, by the equation,

$$E_1 = \frac{2 \pi n^2 N F 10^{-8}}{P},$$

that is, that the magnetism M is proportional to the M. M. F., F, by the equation, $M = \frac{F}{P}$, where the magnetic resistance (reluctance), P, is a *constant* of the magnetic circuit, independent of the magnetization, and determined by the equation, $P = \frac{\rho\, l}{q} = \frac{l}{\mu\, q}$ where, $\mu = \frac{1}{\rho}$ is the *magnetic susceptibility*.

But the magnetic susceptibility of the iron is not at all constant, but on the contrary, very variable; it is a minimum for very low magnetization, increases up to a maximum for medium magnetization, and decreases again, when *saturation* sets in, until for enormously high M. M. F.'s it is almost as poor as that of air.

For instance, the magnetic susceptibility of *air* assumed as *unity*, the susceptibility of good sheet-iron for low magnetization—13,000 lines of magnetic force per square inch—is about equal to 1,100, rises to a maximum of 1,800 for medium magnetization—40,000 to 50,000 lines per square inch—and decreases again, reaching 260 for a magnetization of about 100,000 lines per square inch, decreasing still further for higher magnetization. Ewing followed its decrease up to magnetizations near 300,000 lines per square inch, and found the susceptibility there nearly 2.

All the high-frequency transformers, as for instance the Westinghouse converter, must, because of the loss of energy due to hysteresis, work with a magnetization which is still far below the point of maximum susceptibility, corresponding to a susceptibility of about 1,500 (test).

It is impossible to assume as constant, a coefficient which is as variable as the magnetic susceptibility μ. Hence we have to introduce into the transformer-diagram the *variability of magnetic susceptibility*, that is, of *specific magnetic resistance.* To do this, first the dependence of the magnetic susceptibility of that iron, which is intended to be used, upon the magnetomotive force, that is, the magnetizing current, has to be determined. This is the "*characteristic curve of the iron.*"

A large number of such curves are given by Hopkinson, Ewing and others. They are generally determined by means of the *ballistic galvanometer*. But their determination should be carried out under the same conditions that are met with in transformers, that is, by means of *alternate currents*, by building up a closed magnetic circuit of known length and cross-section of iron, sending alternating currents around the wire coil surrounding the magnetic circuit, and computing, from the measured counter E. M. F. of self-induction of the wire coil, its known number of turns and the frequency of the alternate current, the maximum magnetizations corresponding to different values of magnetizing alternate current.

This way of determination has the advantage of making the result entirely independent of the difference of "*rising*" and "*decreasing*" magnetism, because it corresponds to the value of magnetic conductivity for the maximum

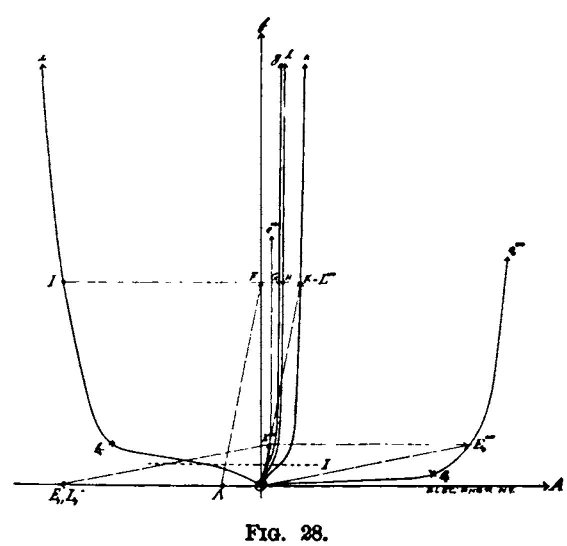


FIG. 28.

point of the complete magnetic cycle, that is, just that value which we need in designing transformers.

Besides, this method is the most convenient and quickest working for determinations of magnetic susceptibilities, and best suitable for use in factories. For use in designing transformers, and considering the phenomena therein, we produce the characteristic curve of the iron in a somewhat different shape. The *induced* E. M. F., denoted I, is proportional to the *magnetism* M, by the equation,

$$I = 2\, \pi\, n\, N M\, 10^{-8}.$$

The *magnetism* M, depends upon the M. M. F., F, by the "characteristic curve," $M = f\,(F)$. Hence we can produce the characteristic curve as the *dependence of the induced* E. M. F., *I*, *upon the resulting* M. M. F., *F*,

$$I = 2 \pi n N f (F) 10^{-8}.$$

Such a curve is shown in Figs. 27 and 28, as *i*. There the horizontal distances, $I = \overline{FI}$ of the points of the curve, *i*, from the vertical line, *f*, give the *induced* E. M. F.'s, the vertical line, $F = \overline{OF}$ the corresponding M. M. F.'s.

A NEW GALVANO-PLASTIC PROCESS FOR GIVING TO NON-CONDUCTORS A CONDUCTING COATING.

A NEW process has been proposed in Berlin by R. Falk, says the London *Electrical Review*, the object being the deposition of a conducting layer or envelope upon the surface of bodies which do not conduct electricity of themselves. The substances experimented with successfully include wax, gutta-percha, wood, plaster, paper, fabrics, glass, &c., and it is stated that flowers, anatomical preparations, the bodies of insects, &c., have been successfully dealt with. The essential features of the process consist in dissolving a salt of silver, such as the nitrate, chloride, bromide, &c., in collodion or in a solution of gelatine, albumen, varnish, or other similar substance. Into the solution thus prepared are immersed the objects to be galvanized, or these objects may be painted over with the solution. When the objects have been thus prepared they are treated with a solution of sulphate of iron, or pyrogallic acid, hydroquinone, ammoniacal copper oxide, &c., substances which will reduce the silver salt to the metallic condition. A fine pellicle thus coats the object, and scattered through this pellicle the metallic silver which has been reduced, and which thus confers upon it conducting powers. All that now remains to be done is to coat the objects with any desired metallic deposit according to any well-known method.

THE TESLA-FERRARIS CONTROVERSY.

IN our issue last week we gave the facts relating to this controversy, stating reasons for our belief that Mr. Tesla is fully entitled to the credit of priority in the discovery and application of the rotating field principle. We are glad to note the following from *Industries* of August 21, that paper having been the first to acquaint the English-speaking world with the work of Prof. Ferraris :

"There has been considerable discussion as to who really invented double and triple current work. The credit seems to lie between Mr. Tesla and Professor Ferraris. The former patented a practical and commercial motor on that principle, and surely he should have the full credit of the invention. We think Mr. Tesla has done far more to make it a practical success than any one, and we hope he will get, not only full credit, but something more substantial than abstract credit as well. At any rate, the invention was not English. Such modifications as using closed coil armatures or triple currents with three wires may be great improvements or not, but they can, in comparison, never rank as original inventions."

Judging from the concluding sentence quoted above, it would seem that our contemporary is still unacquainted with the full scope of Mr. Tesla's work.

FIG. 2.—DYNAMO ROOM, BRUSH ELECTRIC LIGHT STATION NO. 2, BUFFALO, N. Y. (See page 279.)

THE BRUSH ELECTRIC LIGHT STATION AT BUFFALO, N. Y.

C. R. Huntley.

THE fact that the president of the National Electric Light Association, Mr. C. R. Huntley, is secretary and general manager of the Brush Electric Light Co., at Buffalo, gives special interest to the station there, and we take the opportunity of presenting some views of the plant, with a vignette portrait of Mr. Huntley. The station shown is used entirely for arc lighting, but it deserves mention that the management is thoroughly committed to the idea of rendering whatever electric service may be called for, and is preparing for work on a larger and more comprehensive scale. The station is located at a convenient point for central distribution all over the

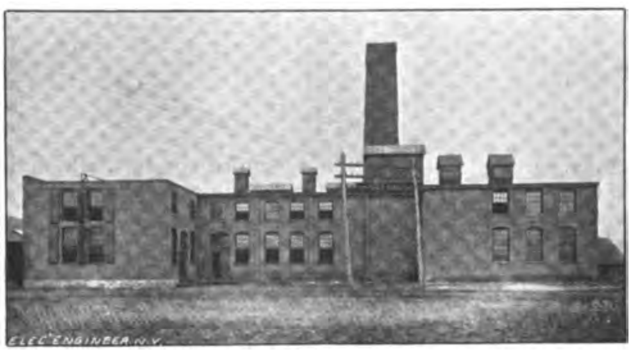


FIG. 1.—BRUSH ELECTRIC LIGHT STATION, BUFFALO.

company's territory, and is also advantageously situated for obtaining an ample supply of water for condensing purposes. Originally it was intended to operate the station by independent high-speed engines, but this plan was abandoned after a trial, and the large engine they now have was installed, the makers being Allis & Co. The en-

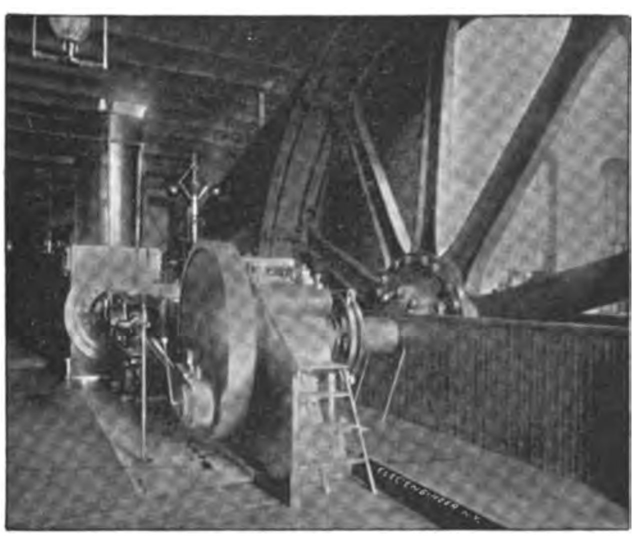


FIG. 3.—ALLIS-CORLISS ENGINE, BRUSH ELECTRIC LIGHT STATION, BUFFALO.

gine is attached to one end of the line shafting and is of the type known as the tandem compound. This line of shafting has 18 clutch pulleys, to which the dynamos are belted, all being upon the same floor, as shown. In this way each dynamo is under absolute control, and as independent as if connected to a separate engine.

As a general thing, the switchboard is one of the show-pieces of a station. At Buffalo, however, nothing special

FIG. 4.—BOILER ROOM, BRUSH ELECTRIC LIGHT STATION, BUFFALO.

is seen in this respect, but the company intends putting in a slate switchboard soon. As a whole, the station (known as the No. 2) is a very economical one. It was designed, and is run, simply for the purpose of making money. The company has avoided any extravagant engineering, and has built upon a common sense plan. There are many things about it that experience shows might have been done better, but, as a rule, those who visit the station commend it for its simplicity.

The boiler capacity of the plant is 900 nominal horse power. It is so arranged that the coal from the cars is thrown directly in front of the boilers, and they are thus able to have a supply of over 1,000 tons in front of the boilers at any time, and that with but a single handling.

The station is already being enlarged, and, as stated above, to accommodate 16 more dynamos, as well as another engine. This new engine will be of 1,500 h. p. and will be used alternately with the present engine. At the present time the company is lighting 1,298 arcs every night, and has a load also of 6,000 incandescents. This may seem a small incandescent business, but, so far, the electric light in Buffalo, is regarded as a necessity—not as a luxury nor as a medium for advertising.

THE THERMAL POTENTIAL FOR DILUTE SOLUTIONS.

IN a paper by E. Riecke in the *Annalen der Physik und Chemie*, the author discusses the thermal potential for dilute solutions. He calculates the potential for the components of a dilute solution, taking as his basis the fundamental equation due to Gibbs. He then applies his results to the consideration of the various phenomena that dilute solutions exhibit, and succeeds in deducing the various laws which govern the lowering of the vapor pressure, the depression of the freezing point, the dissociation of electrolytes, the distribution of a substance between two solvents, osmotic pressure, diminution of solubility and the absorption of gases. It is interesting to notice that the results thus obtained by Riecke from mathematical deduction are indentical with those which have been derived theoretically by other methods of reasoning, and also identical with those obtained experimentally.

MR. HOWARD FISK has been given charge of the steam and electric plant at the Leland Stanford University, Menlo Park, Cal.

THE LAKE SYSTEM OF ELECTRICAL CONDUITS IN WASHINGTON, D. C.

One of the first cities in the country in which the running of wires underground was made compulsory upon the companies was Washington, D. C., and among the very first to undertake the burying of electric light wires was the United States Electric Lighting Company, of that place. Starting in with a bitumen conduit, Mr. Miner Renshaw, the superintendent of the company, after protracted trials of various types of conduit, finally settled upon the Lake underground system of the Washington Conduit Co., a

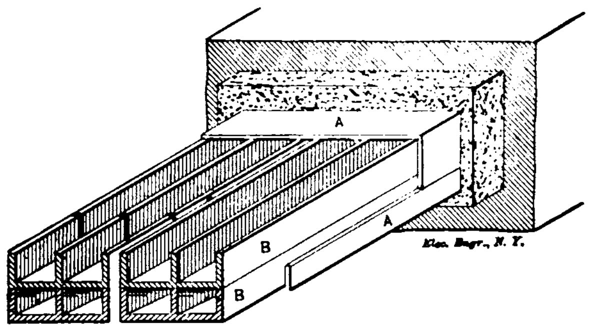


Fig. 1.

considerable amount of which is now in operation and has proved eminently satisfactory. The main idea embodied in this conduit is to provide a system which shall permit of the ready insertion and withdrawal of the conductors, while at the same time being of a nature such that its life is practically indefinite. Evidently a construction embodying only terra-cotta and concrete employed in a suitable manner fulfills these conditions exactly, and the manner in which these have been applied is shown in the accompanying illustrations. Here Fig. 1 shows a type of conduit designed for eight ducts. It is composed of ducts built up in two tiers of terra cotta in the shape of double troughs, the

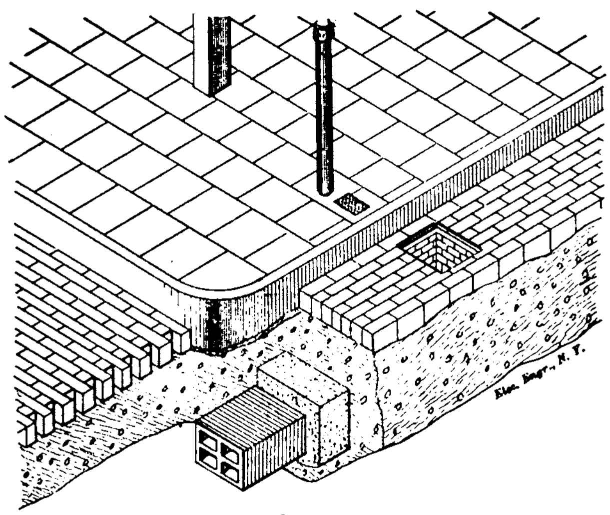


Fig. 2.

bottom of the upper forming the top of the lower. These ducts are covered above and below by a cover, A A. This is set in a bed of concrete, which also completely surrounds the ducts and keeps them firmly in position. A type of conduit with four ducts is shown in Fig. 2, which represents the hand-hole by which connection is made with the wires leading to the lamppost at the curb. The construction adopted where more conduits are required is shown in Fig. 3. Here the conduits are composed of four units of four conduits, each set in concrete as before. The joints between the consecutive lengths are effected by bracket-shaped pieces, D, Figs. 3 and 4, which clasp the conduits and which are held firmly in position by the concrete as it is rammed about them. The system has also been thoroughly provided with the various hand-holes and manholes necessary for getting at the wires, the manhole arrangements being illustrated in Fig. 5.

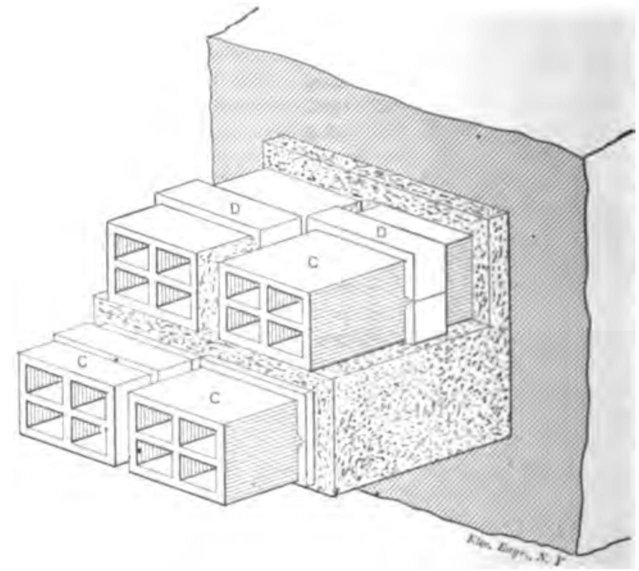


Fig. 3.

It may be mentioned that this form of conduit, which is the invention of Mr. Wilmot Lake, has not only been very successfully used in electric lighting, but is now being introduced in Washington for the telephone lines throughout the city. In fact, the conduit is highly approved of

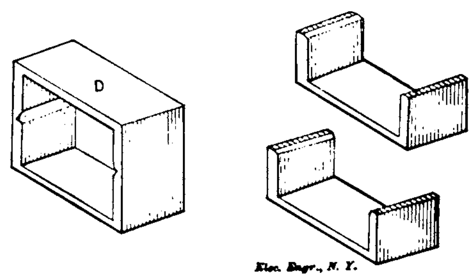


Fig. 4.

by all who have witnessed its operation there, and bids fair to find a very general appreciation all over the country. The United States Electric Lighting Co., in Washington, has 30 to 35 miles of it with a cable capacity of over 500 miles. The Chesapeake & Potomac Telephone Co. are now completing five miles with a cable capacity of at least 250

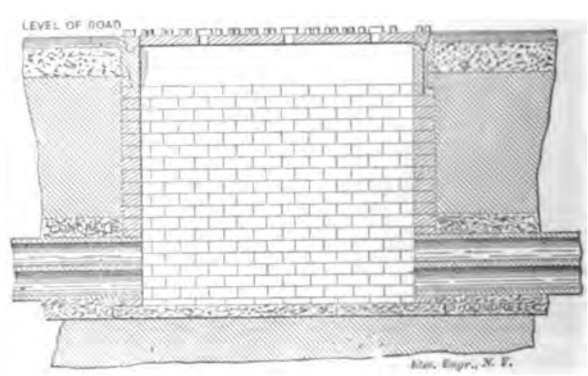
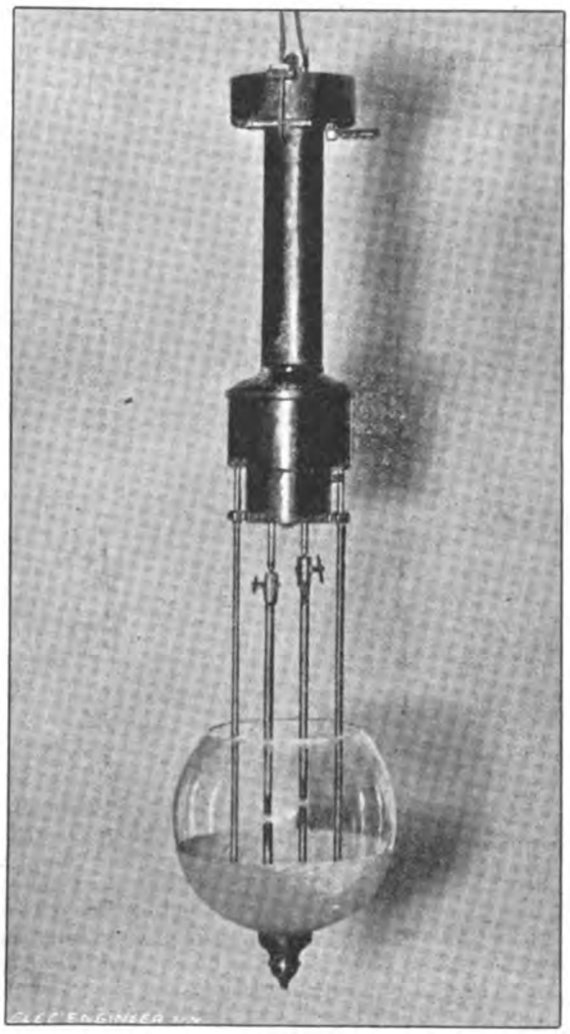


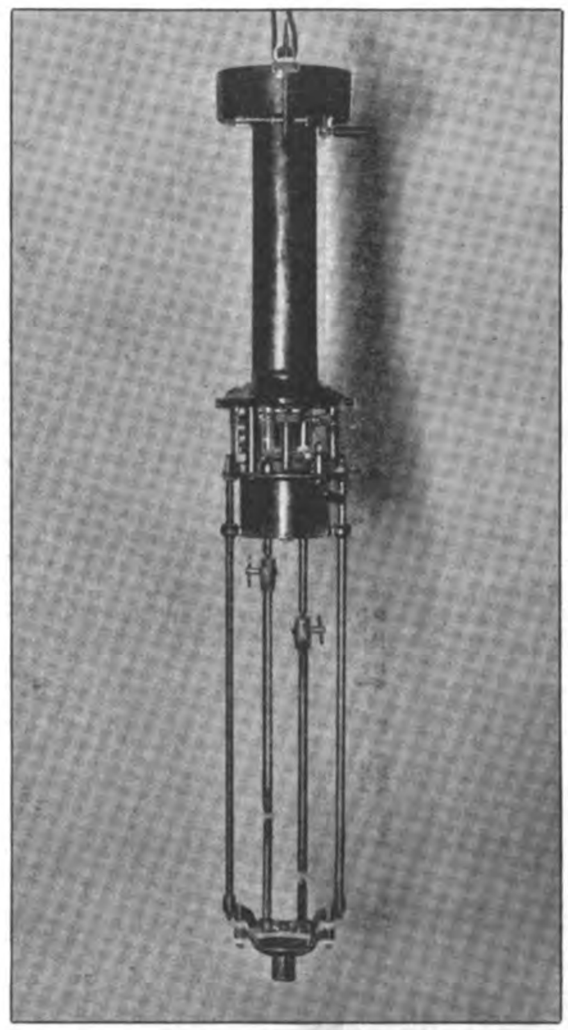
Fig. 5.

miles, and the same telephone company laid ten miles last year in Baltimore. The system is also coming largely into use in Chicago, St. Paul, Minneapolis, Cleveland, Louisville, San Francisco and Milwaukee.

THE NEW HOCHHAUSEN DOUBLE-CARBON ARC LAMP AND MOTOR-STARTING SWITCH.

The Excelsior Electric Co.'s new arc light machine, which was described in The Electrical Engineer of April 23, 1890, has already gone into operation in a large number of installations, and has sustained Mr. Hochhausen's reputation as a designer of electrical machinery. More recently he has devoted his attention to the construction of a double-carbon arc lamp which embodies a number of features well worthy of attention and which cannot fail to place it among the best of its type. The lamp complete is shown in the accompanying engraving, Fig. 1, and Fig. 2 shows it with the covers removed, exposing the mechanism. A glimpse at the mechanism might, at first sight, make it appear that no magnet spools were employed, but a closer inspection reveals the fact that they are all enclosed within iron shells, which have a double function, namely, to protect the spools, while, at the same time, acting in the role of bell magnets.





Figs. 1 and 2.—The Hochhausen Double-Carbon Arc Lamp.

The operation of the lamp will be best understood by reference to the diagram, Fig. 3. The lamp is so constructed that before current is applied, the carbons are drawn apart. The bell-shaped magnet, placed below the exposed mechanism, has two windings; one of these consists of a coarse coil, E, Fig. 3, while the other consists of fine wire, E^2, both these magnet spools being in shunt to the arc, as shown. Thus, when the current is turned on, the coarse coil E exercises sufficient power to draw down the lid-armature L, to which the rod clutches are attached, and allows the carbons to descend. As soon as the carbons have come in contact they complete the circuit of the magnet-spool enclosed in the shell G, which spool is in series with the carbons and consists of coarse wire. The action of this spool is to draw up its armature, G^3, at the other end of which is supported an insulating button, G^4; this button raises the spring contact G^5 from G^6, and opens the coarse shunt E. The arc is now under the sole control of the fine wire shunt E^2 and a retractile spring which opposes its action.

During the burning of the first set of carbons the other set is held up rigidly by a lever on the lid-armature. The top of the first carbon rod is provided with a button, which is so arranged that when the carbons are burned out the button trips the lever holding the second set of carbons, which are thus immediately brought into action. The action here described is exceedingly simple, and the operation of the lamp in service is very smooth.

Mr. Hochhausen has also devoted special attention to the details which facilitate the cleaning of the lamp and also insure the safety of the trimmer. For this purpose the small lever, shown at the side of the lamp mechanism in Figs. 1 and 2, when operated, depresses the lid-armature and releases both carbon rods, which can be freely slid up and down for trimming. At the top of the mechanism there are provided spring terminals which clamp, and thus make good elastic contact with, a set of terminals on the top of the lamp roof. This obviates the necessity for screw connections, which are usually troublesome to get at and frequently work loose or fail to be screwed up tight by the attendants.

The lamp-hanger, it will be noted, consists of an inverted cast-iron hood containing a slate base, which carries all the terminals and a cut-off switch. Unlike the usual cut-out

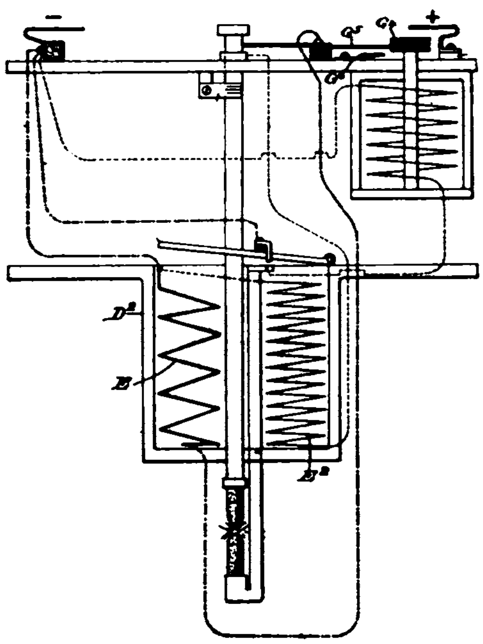


FIG. 3.—HOCHHAUSEN NEW ARC LAMP.

switch, which merely shunts the lamp without putting it out of the circuit, this switch cuts the lamp off entirely from the circuit, so that the attendant is perfectly safe even in the dampest weather. Here, also, the arrangement is such that the mere insertion of the lamp into the hanger effects the contact automatically, so that no screws are required. The arrangement is evidently waterproof, and, besides requiring no hanger-board, obviates the necessity of a hood. Besides the mechanical protection afforded by the magnet-

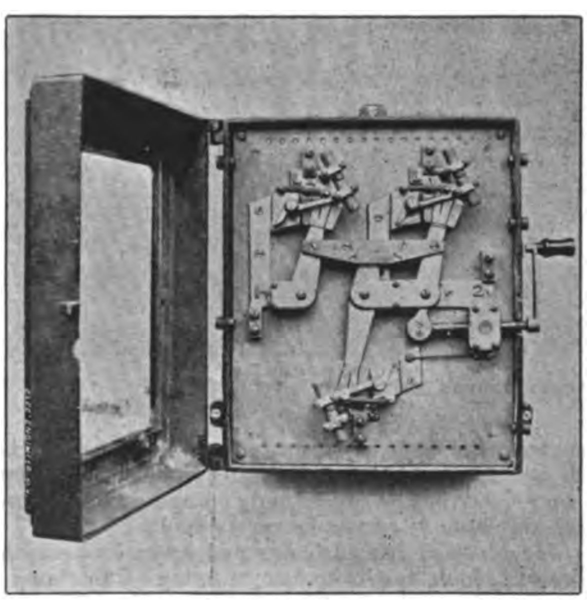


FIG. 4.—HOCHHAUSEN CONSTANT POTENTIAL MOTOR STARTING SWITCH.

spools by surrounding them entirely by iron, Mr. Hochhausen believes that the fine-wire spool will also be largely protected from lightning, and the results already obtained by the lamp in practice appear to bear him out in this regard.

The constant-potential motor-starting switch designed by Mr. Hochhausen is shown in perspective in Fig. 4, and embodies several novel features. A switch of this nature must evidently be so constructed that the field is fully charged before the circuit is closed to the armature in order to avoid the dangerous effects of the heavy current passing through an armature revolving in a weak field and at slow speed. At the same time the arrangement must be such that in shutting down the motor the armature circuit is broken first and followed by that of the field, and for a similar reason. To this it is desirable to add an arrangement which shall avoid excessive sparking at the contacts, and in fact to relieve them of such sparking entirely.

The manner in which this has been carried out by Mr. Hochhausen will be apparent from an inspection of the diagram, Fig. 5. Here, it will be seen, the generator or line is connected to the terminals L L, below which are three other contacts, marked 1, 2, and 3. The contacts 1 and 3 are connected to the armature ends, while 1 and 2 are connected to the field ends. It will now be readily understood that when the attendant begins to turn the crank H the levers A and A′ are gradually drawn over until they come under the spring clips attached to the terminals, marked L

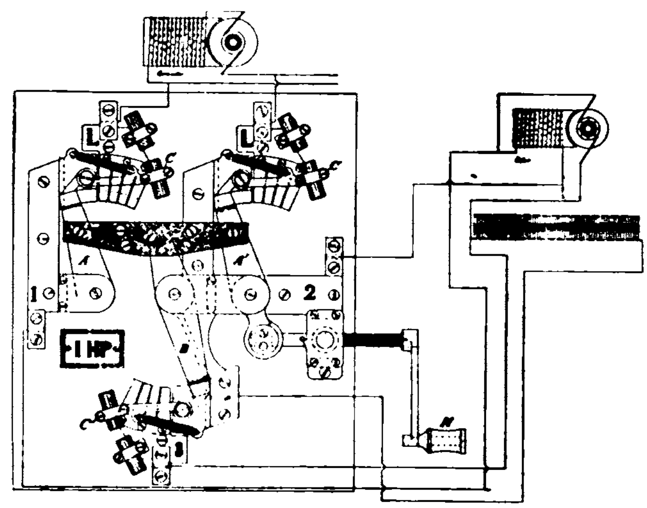


FIG. 5.—HOCHHAUSEN NEW ARC LAMP.

L. After this contact is made, but before the levers have come to the end of their throw, the lever B is started in motion by the cross-piece E, connecting the levers A A′, and at the end of the stroke the lever B has made firm contact with the clips attached to the terminal 3, thus cutting the resistance coils out of circuit and throwing the full armature in circuit. When the motor is to be stopped the handle H is turned in the opposite direction, and by reversing the movement of the various levers the armature has the resistances thrown in circuit with it, is then cut out of circuit and this is followed by the cutting out of the field magnets from the line.

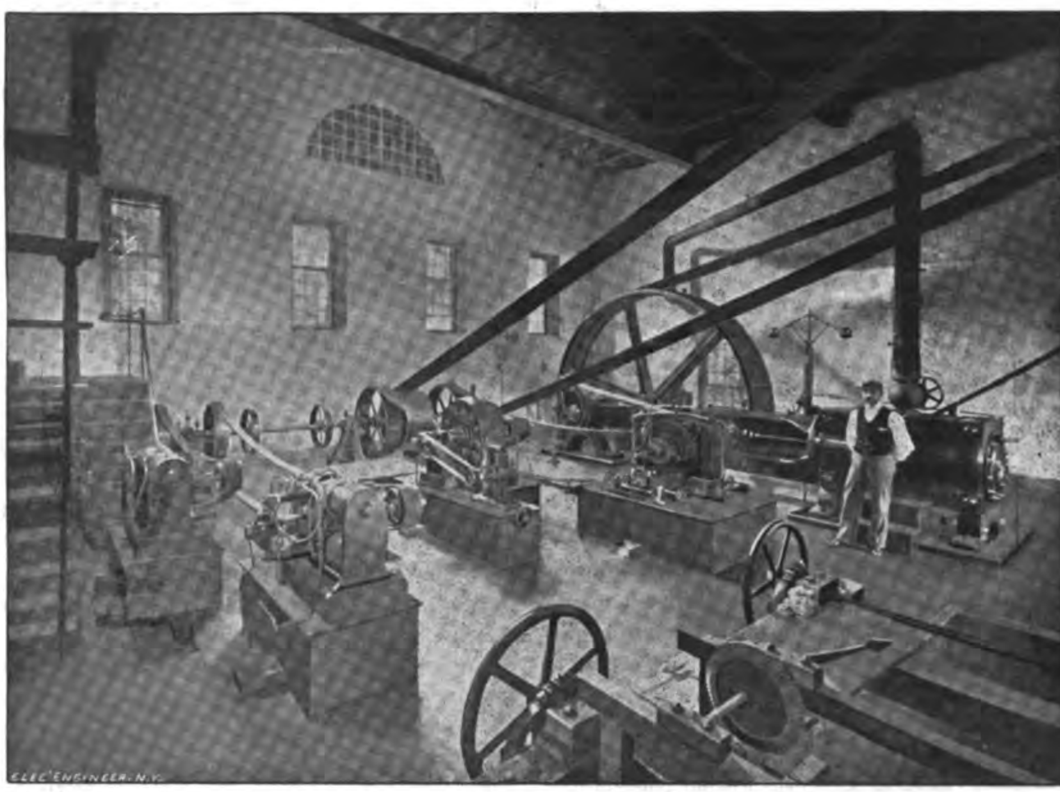
The motion of the crank H is limited in both directions by stops, so that when the handle can no longer be turned the proper contacts have been effected. It will also be noted that the levers A, A′ and B act upon a second set of levers, C C C, which carry carbons at their ends, and which make contacts with corresponding carbons attached to each of the terminals L L and 3. It will readily be seen that as the levers A, A′ and B are withdrawn by the action of the crank, the springs pull the levers over and bring the carbons in contact, the arrangement being such that these carbons come in contact before the levers A, A′ and B meet their corresponding contacts L, L and 3. Similarly, when the motor is shut down the levers A, A′ and B first break contact at L, L and 3 and are followed by the breaking of the contacts C, C, C. The result is that any sparking which occurs is confined to the carbons alone, thus leaving the brass clips and the contact levers entirely clean and bright.

The entire operation will thus be seen to be automatic, and from its nature such that by no possible circumstance could the attendant cause an abnormal rush of current through the motor, the screw of the crank H being so designed that several seconds must elapse between the energizing of the field magnets and the turning on of the current to the armature.

The contacts and levers are all mounted on a slate base and the resistance coils are mounted at the back of the box, which is of cast iron. The resistance is such that the motor starts with good power without endangering the armature.

THE LA ROCHE PLANT AT THE DU PONT POWDER WORKS, WILMINGTON, DEL.

The accompanying illustration shows a plant recently installed by the La Roche Electric Works, of Philadelphia, for Messrs. E. D. Du Pont, de Nemours & Co., powder manufacturers, at Wilmington, Del. The plant consists of one 50 arc light dynamo, one 500 light alternating dynamo, and two 200 light direct-current dynamos, all driven by a 300 h. p. Corliss engine, built by Messrs. Robert Wetherill & Co., of Chester, Pa.



La Roche Electric Light Plant, Wilmington, Del.

The arc light covers an area of five miles, while the alternator has a circuit six miles long, giving light through the Du Pont mansions and some of the mills.

The direct-current machine furnishes light and power for three of the Du Pont mansions. The Schieren link belts and Grimshaw wires are used throughout. The line construction is excellent, showing only a two per cent. drop at the distance of six miles.

A part of the plant has been in operation for some time, and is said to require less attention, and to give better service, than any system tried heretofore by the company.

The La Roche Electric Works placed two 150 light incandescent dynamos at one of these powder mills about three years ago under the most severe conditions; that is, the dynamos were started up in the evening and left to take care of themselves until the next morning. It was largely due to the extremely satisfactory results accomplished by the La Roche machines that the firm were led to adopt the La Roche system throughout. During the recent heavy electric storm the La Roche machines ran steadily throughout the night.

The dynamos are insulated at their bases, and the general system of insulation is so perfect that no accidents have occurred causing injury to persons or property at any time since this system has been installed. It is the general opinion of experts who have inspected this plant that no more complete and perfect a one has been installed in that part of the country.

TELEPHONIC COMMUNICATION BETWEEN STOCKHOLM AND CHRISTIANIA.

The last Swedish Parliament granted a sum of 60,000 crowns for the purpose of extending the telephone to the Norwegian frontier, on the condition that Norway should bring her telephone wires to the Swedish border. According to Norwegian papers the Storthing has acceded to this condition, so that direct telephonic communication between Stockholm and Christiania will shortly be established.

TELEGRAPHY IN HAYTI.

A special cable dispatch from Port-au-Prince of Aug. 15 says: The resignation of the Cabinet yesterday was owing to the failure of the Chambers to grant a concession for the construction of a telegraph line. The Cabinet had made this a government question, and as the Chambers rejected the proposition by a decisive majority, they at once placed their resignations in the hands of the president.

Hippolyte has not yet decided whom he will select for the vacant places, but is canvassing the situation carefully. He does not think the resignations will have much political effect.

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EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. XII. NEW YORK, SEPTEMBER 9, 1891. No. 175.

There are certain arts in which perfection depends upon the genius and skill of the individual rather than on the condition of the race.—Joseph Henry.

ELECTRIC LIGHT AND POWER IN CANADA.

WHILE we do not expect that American manufacturers of electrical goods and apparatus will derive much direct benefit from the visit of the National Electric Light Association to Montreal, though there will doubtless be a little, we are decidedly of the opinion that the convention should have as one result a stimulus to electrical interests in the Dominion itself. The fact that there are duties, and that manufacturers have already established themselves on a large scale, is enough to prove that Canadians propose to look after supplying their home market themselves. It is true that a good deal of the apparatus now in use bears American names, but even then it has largely been made on Canadian soil, and there are indications that the proportion of home product will be larger as time goes by. So long as we in America are willing to handicap ourselves by heavy taxation on raw materials, we must expect to lose no small amount of trade that is legitimately ours; and the wonder is that this country has been able to compete at all beyond its own borders, even in articles distinctively the outcome of American genius and skill.

Be that as it may, however, it is gratifying to see many signs of electrical activity in Canada, and to believe that this Autumnal picnic will help enlarge the opportunities of our Canadian brethren. It is noteworthy that in Canada much has been done in the utilization of water powers, but that there is still plenty of room for such work is evidenced by the fact that right at the doors of Montreal the Lachine power still goes to waste when it would light the whole city, run all the street cars and drive every piece of machinery. As might be expected from the conditions, the alternating system enjoys considerable vogue in the Dominion, and in the power transmission of the near future it will undoubtedly be relied upon for the performance of some very heavy work. It may be expected also that in Canada, with its cheap water powers and bitter winters, we shall soon see some very interesting and successful plants for electric heating, for heaters have now reached the stage of commercial usefulness, and may be applied in almost as many ways as motors are. There are at the present time in Canada not far short of 150 central station plants in operation, with about 12,000 arc lights and 60,000 incandescents; and of these plants about 25 per cent. are operated by water power. This is a much larger proportion than is found in the United States, and though the water power stations are not among the largest, their rapidly increasing number shows that our Canadian friends are fully aroused to the desirability of turning this store of energy into electric current for all the varied purposes it is now put to. In electric motor and electric railway work, Canada, so far, has not done much, but a promising start has been made, and while we need not look for the headlong American rush in their development, these departments will, without question, grow steadily and surely.

THE CURE OF DYNAMO AND MOTOR TROUBLES.

ALTHOUGH the modern text books on electricity aim more and more at presenting the subjects treated in their practical bearing, it is none the less true that they must necessarily fall short of the ideal in this direction; for, however much an author may seek to treat the subject as it presents itself in actual practice, the limits of his work necessarily compel him to curtail this side of the subject in order to preserve the continuity of the work. If to this we add that comparatively few writers have enjoyed comprehensive "practical" experience, which alone can make their work of genuine value to the student, the reason for the complaint that the text books are not "practical" enough will be apparent. The literature of the steam-engine affords many excellent works of this practical character, but up to the present time no work has so far been forthcoming which will enable one, by direct application, to install and care for a dynamo or motor. It is true that numerous rules and directions intended for this purpose have been issued by various companies, and a very good digest of the "Diseases of Dynamos" was once made by Prof. Silvanus P. Thompson, but none of these afford the engineers in charge of dynamo electric machinery that sufficiency of information which makes them independent of the "expert," who may be a thousand miles off. To place the average dynamo and motor attendant in possession of such information will therefore be acknowledged to be a work not only of immediate benefit to a large class of station employees, but will also prove of especial benefit to those in charge of isolated plants and who are usually entirely at sea when the slightest mishap occurs in the operation of the electrical plant. It is with the object just mentioned in view that Prof. F. B. Crocker and Dr. S. S. Wheeler have taken up the subject of the care of dynamos and motors, and have, we believe, for the first time, subjected to systematic treatment a subject which may well claim the attention of the ablest minds. In the publication of their work, which we begin in this issue, the authors first take up that part of the subject which will at once appeal to the dynamo or motor attendant, and which above all others he will most likely have occasion to refer to on future occasions, namely, the localization and remedy of "troubles." The method adopted in presenting this subject will recommend itself by its logical and effective character. The authors first group the various troubles under eight general heads, which are subsequently taken up in detail. Thus the search for a remedy is at once narrowed down and application can be effected with the shortest possible delay. Many of our readers will without doubt be able to recall instances of "trouble" which required days and weeks to localize and to remedy, but which would have been disposed of in a fraction of an hour with the aid of a guide such as that of Messrs. Crocker and Wheeler. The long experience of the authors both in designing and in the practical operation of dynamos and motors gives to their work that character of "practicality" which will cause it to be welcomed by all engaged in the operation of dynamo electric machines.

GOVERNMENT TELEGRAPHS IN ENGLAND.

The subject of government telegraphs is likely to be actively discussed in this country for a long time to come, and every valuable contribution to the data on the question deserves note. Mr. E. Rosewater, editor of the *Omaha Bee*, an old telegrapher, who was recently elected president of the Old Timers' Association, has an interesting article in his paper on the English and French services, based on his personal observations and notes. Mr. Rosewater makes out a strong case, it is true, and it will readily be admitted that there are many things to admire in those services, though perhaps not much in any of the others, except the German. But the things that win Mr. Rosewater's praise are not necessarily the results of government control; on the contrary, they seem to us, at least, in England, results of the national characteristics, asserting themselves despite unfavorable conditions. But at the end of his letter, Mr. Rosewater touches on the political aspects of the matter, and states significantly, that while the employees are not interfered with politically, "they are not permitted to act as political agitators, or to take part in public meetings." He adds that in France M. Magne, the director general of telegraphs, said he would go further and divorce the service entirely from politics by placing it on the same footing as the army, which, it is stated, does not vote. Now we would like to know if any considerable body of men in America, and if the telegraph operators themselves, wish to see telegraph employees in any such muzzled condition. If they do, the future of America is not a particularly bright one. American freedom is based on a passionate attachment to the idea of personal liberty of conscience and action, and the bare idea that any man, to hold a government position, would sacrifice his right to agitate against wrong, or abandon his influence in removing evils, is abhorrent to every principle upon which this government is founded.

MR. FERRANTI AND THE DEPTFORD STATION.

The work accomplished by Mr. Ferranti in connection with the Deptford station in London, and the prominence which has been given to it owing to the gigantic nature of the enterprise, makes the rumor that Mr. Ferranti has severed his connection with the company of more than ordinary interest. It is safe to say that in no other enterprise of like nature has the individuality of one man been given freer play than in the Deptford station, Mr. Ferranti not only designing all the electrical, but the mechanical equipment as well. The difficulties which had to be surmounted in carrying to a successful completion the task which Mr. Ferranti had set himself would have deterred any one not endowed with a will of iron. In addition, they called for the exercise of the highest skill and ingenuity. True, mishaps have not been wanting in the course of this work, but what great undertaking which required the application of new and untried forces has ever been free from them? While it is yet hardly time to judge Mr. Ferranti's work, no one will, we believe, deny him the credit due to a pioneer in the generation and distribution of current at higher tensions than had been deemed practicable before the inauguration of his work. Now that Mr. Ferranti finds himself freed from the cares which have absorbed his attention abroad so long, it is not improbable that he may find time to pay a visit to these shores, where possibly he may find further opportunities for the exercise of his enterprise and skill.

ELECTRIC LIGHTING FIGURES.

Last week, in commenting on Mr. Tiffany's census figures of electric lighting, we called attention to the absurdity of one statement, which credited San Francisco with paying $440.67 for one arc light. It is just such figures as these that are seized upon by ignorant critics as a weapon of offense against local lighting companies, and hence we already find the following in the Kansas City, Mo., *Journal:* "San Francisco *is robbed* by its electric light company, which collects $440.67 per arc light, while Denver pays only $58.46. It certainly does not cost eight times as much to run an arc light in San Francisco as it does in Denver." Then alluding to the fact that in New Orleans each gas lamp apparently costs $50, while in Indianapolis it only costs $15, the *Journal* adds: "The strong probability is that a ring has been getting in its work in New Orleans and San Francisco, and that the boys had to be fixed generously when these contracts were made." Now this is all wrong, but one cannot blame the *Journal* writer, who simply finds these figures in a public document that has presumably been issued with care. We all know that no single arc light in San Francisco costs such a sum as $440. On the contrary, it is common knowledge also that the rates there are about the average for city lighting. A gross injustice has been done the local San Francisco company, but of course there is no redress. If we are to have any figures on electric lighting, let them be correct.

SIEMENS & HALSKE'S EXHIBIT AT THE FRANKFORT EXHIBITION.

In order to show how they can adapt themselves to every kind of electrical work, Messrs. Siemens & Halske have made up a sort of complex electric light and power exhibit, containing combinations of direct and alternate current generator, motors and transformers, all coupled up together, and transforming from one system to the other and back again, and to all sorts of different pressures and currents. The station works incandescent lamps, direct-current arc lamps, tramways, search lights and motors, and these are scattered about over the whole exhibition.

The electrical power is generated by two dynamos, which are the largest in the exhibition. One is an alternator, the commutator. The outside winding is made of solid copper strips, 1.2 in. high by 0.24 in. broad, insulated from one another by fibre. The whole of the winding is turned up true on the outside, and ten sets of brushes, corresponding to the ten poles of the machine, collect in parallel. These are mounted on a star-shaped casting mounted on the outside bearing of the engine proper. This arrangement is exceedingly simple and very accessible. The brush-holders are so constructed that every brush can be independently adjusted during work without disturbing the others, and at the same time the position of all the brushes may be altered at once by an ingenious and simple device, and all the brushes can be lifted off or put on the armature simultaneously by moving the controlling lever. All the posi-

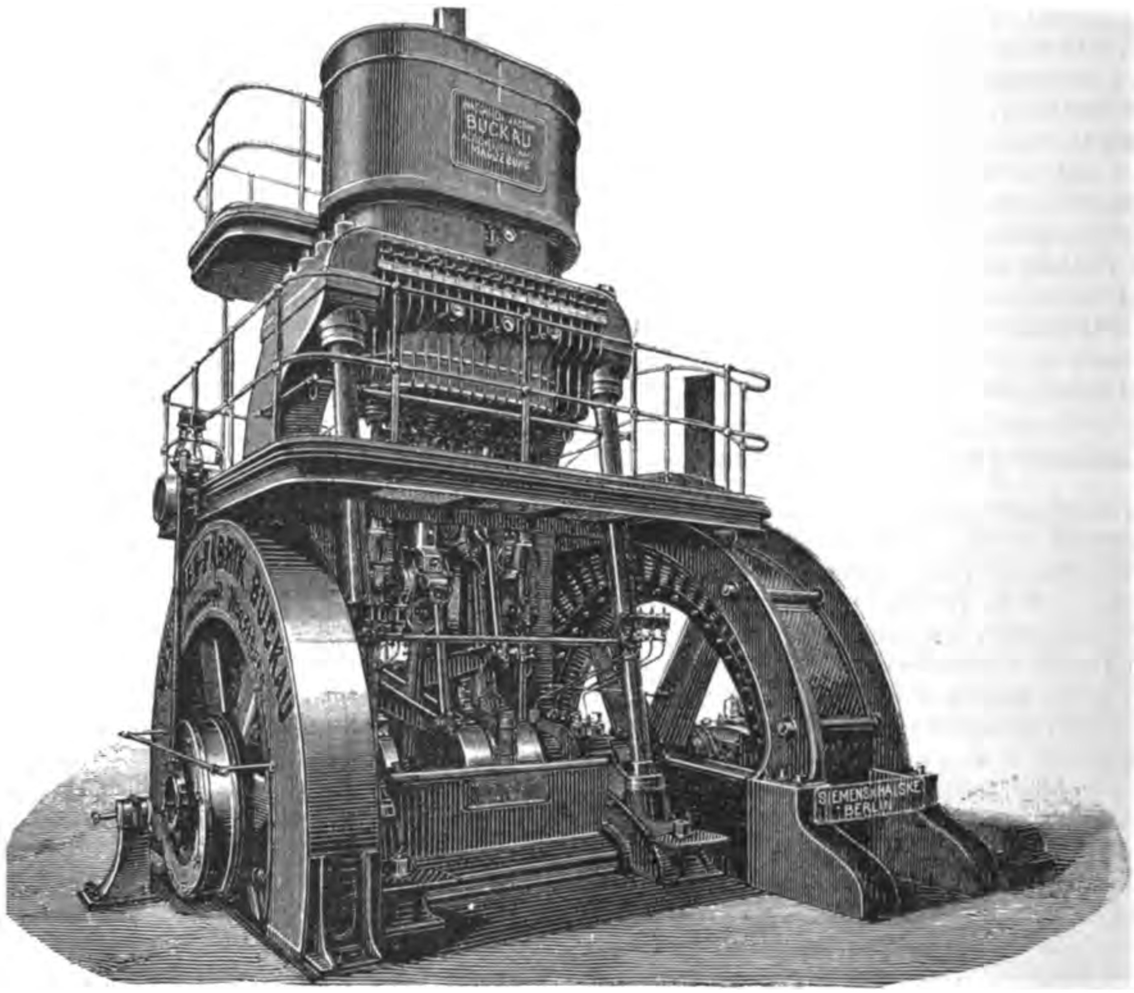


Fig. 1.—Siemens & Halske Alternator Driven by Triple Expansion Condensing Engine.

other a continuous-current machine, and either of them can alone supply the whole distributing system.

The engines are both of the vertical marine type, as shown in the illustrations, Figs. 1 and 2. The continuous-current machine is driven by a triple-expansion condensing engine, by Messrs. G. Kuhn, of Stuttgart-Berg. It has three cylinders, of 20 in., 28 in., and 47 in. diameter, respectively, and 2 ft. stroke. It develops 400 h. p., 500 h. p., and 600 h. p. when run at 80, 100 or 120 revolutions per minute.

The dynamo, made according to Messrs. Siemens' latest design, is coupled direct to the engine shaft. It is a ten-pole machine, radial electromagnets placed inside a Gramme armature of 10 ft. diameter, giving a normal output of 330,000 watts at 65 revolutions per minute, or of above 600,000 watts at 100 revolutions. An interesting feature of these machines is the total want of a special tive and all the negative brushes are connected in parallel, and the current is carried off by two thick but flexible cables visible above the bearing in Fig. 2. This dynamo runs at 150 volts.

The alternate-current dynamo and engine are shown in Fig. 1. The vertical engine is built by the Maschinen Fabrik Buckau, of Magdeburg. It is a two-cylinder condensing engine of the Colman type. The high-pressure cylinder is arranged below the low-pressure and as close as possible to the low-pressure piston rod. The moving systems of the two engines—that is to say, the pistons, piston rods, connecting rods, and cranks—are made of exactly the same weight, so as to balance each other perfectly in all positions, while both cranks are placed as close as possible so that the various thrusts on the bearings are all but compensated. Thus, for a given size, comparatively high speeds are admissible. The engine exhibited, for instance, can easily run at 150 revolutions per minute. At 100 revolutions, which is the normal speed of the alternator, this engine indicates 450 h. p., while the alternator is originally designed for an output of 500 h. p. at the speed named. This discrepancy arises from arrangements with the builder having been made after the dynamo was begun.

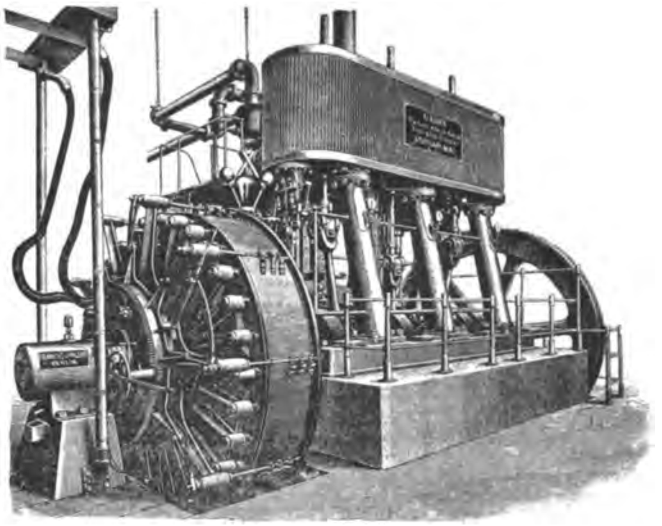


FIG. 2.—SIEMENS & HALSKE CONTINUOUS CURRENT GENERATOR.

The alternator itself consists of a star-shaped field magnet and a fixed external armature, both field magnet and armature being made of laminated wrought iron. Each contains 60 coils of 56 and 20 turns respectively. The conductors are made of twisted copper rope pressed into a square shape, and soaked with varnish in order to avoid eddy currents, the cross-section of copper amounting to about 0.125 square inch. The cross-section of the iron in each core is 20 in. by 3½ in. The rotating field magnets are excited by a separate generator of the same type as the large continuous-current machine already described, and coupled directly on the shaft of a small 60 h. p. vertical engine, by Messrs. Daevel, of Kiel. The stationary armature of the large alternator contains the same number of coils as the rotating field magnet. The cores are **U**-shaped stampings, with the free ends turned inward. When wound and put together they form a sort of laminated Pacinotti armature turned inside out. Any coil can easily be disconnected and taken out without dismounting the rest. The alternating pressure generated at the terminals of the machine is 2,000 volts.

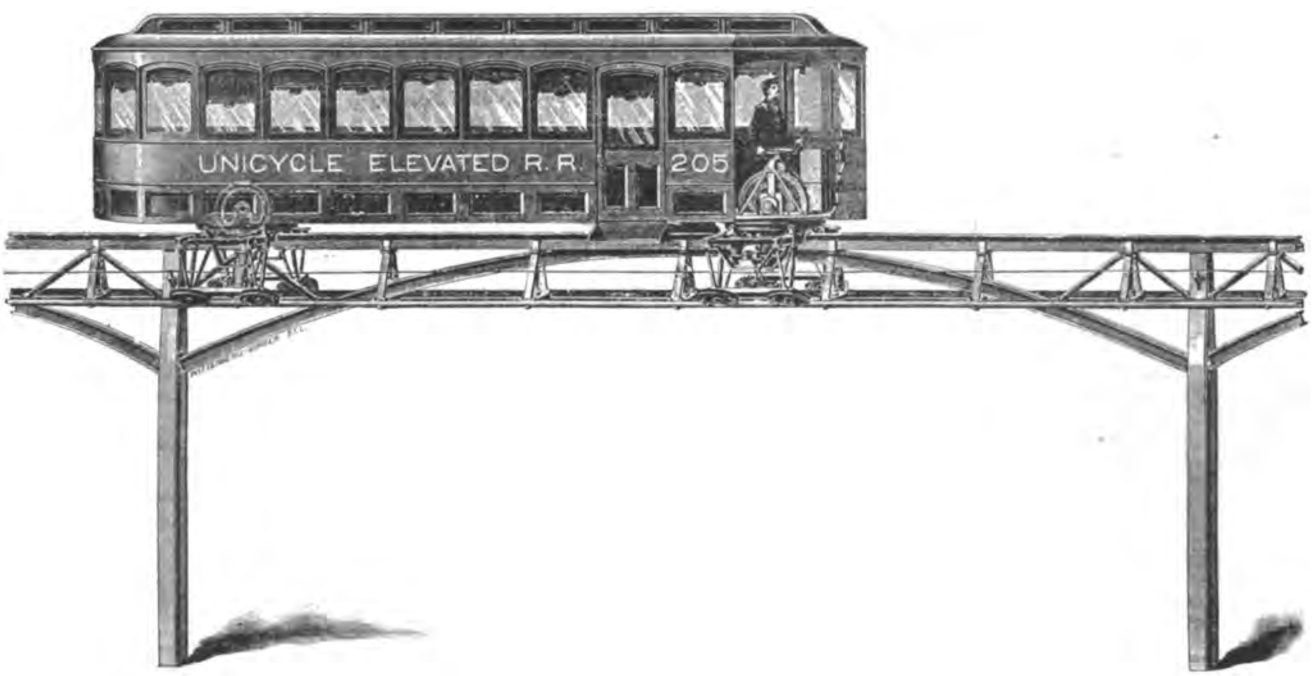
THE UNICYCLE ELEVATED ELECTRIC RAILWAY, ST. LOUIS.

DURING the past four months the Unicycle Elevated Railway Co. have had on exhibition at their headquarters, Nos. 14 and 16 North Seventh street, St. Louis, one of their improved unicycle motor cars in practical operation on a short line of continuous track. The track has loop ends with curves of ten feet radius and also compound curves of eight feet radius. The straight-line portion of the structure is built of steel and iron and the curved portions of wood, so as to illustrate the two different methods of construction.

The, car which is illustrated in the accompanying engraving, is sixteen feet in length and is mounted on two unicycle trucks, which are swiveled to the car by means of flanged segments and anti-friction rollers, thus permitting the car to turn short curves with the greatest freedom.

The trucks and car are locked together by Z-shaped safety hooks. Each truck has a double-flanged main wheel and four double-flanged guide wheels. The flanged guide wheels serve the purpose of locking the truck thoroughly to the track. Two electric motors of three h. p. each are mounted in the lower part of the truck frame, one on each side of the track, and both geared directly to the main driving wheel. Two trolley wheels are attached to the inner ends of the motors and make contact with two trolley wires, which are strung along on both sides of the track. A hand brake, operated by a hand wheel and screw, is located at the top of the main driving wheel.

During the past few months the company have made many improvements in the details of their system; an arch beam has been added to the track structure, as shown in the illustration. Another improvement consists in slightly elevating the track at stations, so as to always have the advantage of a down grade at the start and also to aid in braking the train when stopping. Among other advantages claimed for this system are reduced cost of structure, being about three-quarters of the cost of double-rail elevated roads, higher speed, reduced operating expenses and the ability to turn a shorter curve than any other system. The company are now prepared to make bids for the complete construction and equipment on their system of railway.



THE UNICYCLE ELEVATED ELECTRIC RAILWAY, ST. LOUIS.

THE "S. C. P." MINER'S LAMP.

A PAPER lately read by Mr. Smith before the Federated Institution of Mining Engineers describes the S. C. P. Miner's Safety Lamp. It is claimed for this lamp, writes our London correspondent, that it more nearly resembles in size and form the ordinary oil safety lamps in general use than any other yet invented. By unscrewing the bottom, the lamp or bulb can be replaced by a new one in a few seconds; and in the same way the lamp glass, which is of the ordinary or standard size now in general use, can also be replaced the same as in the oil form of safety lamp. Another feature is that each of the cells composing the battery is separate and independent, and should any accident or fault require one or more of these cells to be replaced, it can (unlike those now in use) be done in a few minutes at the colliery, spare cells being supplied and kept in stock. This fact is of great importance, for in the older forms, if one cell failed the light became dull, and there was no means of telling which identical cell it was; but in these lamps, if any irregularity is observed, such cell can be tested in a few minutes with the voltmeter, and the bad cell taken out, a new one put in, and the lamp sent in as usual, thus obviating the necessity of many extra lamps, whereas in the ordinary forms the lamp has to be returned to the maker, causing much delay and expense. This advantage is said to avoid many of the irregularities found in other electric safety lamps.

The cells are made with a special plate, which gives greater electric capacity for a given weight than any other. It has a high charge-retaining power, is free from local action and sulphating, and there is little or no deterioration of the plate. A plate taken from a battery which has been two and a half years in use shows the truth of this statement.

The battery is of the secondary or storage type, and is contained in a circular metal case, avoiding the use of wood, which has hitherto been too prominent a feature in electric miners' lamps. There are two small studs, marked + and —, at which the dynamo machine is connected to recharge the lamp, and from a third similar stud a small strap of metal switches on the lamp. A nut screws on + and can be so shaped that it can only be removed by a special key, thus (if necessary) forming a lock, as in the old safety lamp. Should the miner succeed in taking out the bulb the light goes out, and if he replaces the bulb the lamp immediately relights itself. The lamp is furnished with the usual "S" hook handle in place of the leather handle too often used in new forms of electric lamps. The smaller lamp is said to burn 7 or 8 hours, the larger one 10 hours. The smaller lamp weighs about 3¾ pounds and is reported to give 15 per cent. more light than an ordinary safety lamp. The larger lamp is double the size of the smaller one; it contains double the number of cells, and gives double the light, and is, of course, heavier in weight. The lamp obtained a silver medal at the recent Falmouth Exhibition of the Royal Cornwall Polytechnic Society. It is made by Messrs. Cathcart and Peto, of London, from designs furnished by Mr. Smith, and is of very recent manufacture. So early has it been brought before the institution that the price has not yet been decided upon, but the makers hope to be able to produce it at a price within the reach of colliery proprietors and engineers.

A MORAL ASPECT OF ELECTRIC LIGHTING.

INSPECTOR MARSH has suggested to Chief of Police McClaughry, of Chicago, the advisability of placing gas or electric lights at alley entrances to all streets. "I believe," said the inspector, "that one of the chief aids to crime in this city is the darkness of the alleys. Our streets are lighted, but most of our alleys are left in utter darkness. When a burglar desires to effect an entrance to a building he works in an alley, where he cannot be detected, and the same advantage is naturally used by the footpad, the assassin and other desperate criminals. The flash-light carried by an officer is of little use to him either in investigating an alley or in searching for fugitives who may have sought refuge there. I believe that if the alleys were properly lighted we should soon notice a remarkable decrease in the percentage of crime." The chief was favorably impressed with the idea, and Commissioner Aldrich will be asked to take some steps to put it into practice.

"THE TRAMWAY AND RAILWAY WORLD."

A PAPER of the above title is to be published in London, under the management of Mr. Frank X. Cicott, of Chicago. It will be a monthly review and will be under competent editorial direction. A very good field appears to exist in England for a journal of this kind, and we have no doubt that by enterprise and ability it will be made a distinct success. It already has the promise of excellent support. The publication offices are at 16 St. Helen's Place, London, E. C. The American offices are at 11 Adams street, Chicago.

College Notes.

ELECTRICAL ENGINEERING AT THE UNIVERSITY OF WISCONSIN.

A special circular of information has been issued relative to the College of Mechanics and Engineering at the University of Wisconsin, Madison, Wis. One of the new professorships there is that of electrical engineering, and Mr. Dugald C. Jackson, as recently announced, will fill that chair. The course in electrical engineering is nearly identical with the mechanical engineering course during the first two years, since a large part of what is required in mechanical engineering is necessary to a thoroughly equipped electrical engineer. In the last two years those subjects given in the mechanical engineering course which are not important to the electrical engineer are omitted and electrical studies substituted therefor. As now arranged, the special features of the course begin with physics in the second year and followed by two consecutive years of electrical study. There is given first a thorough grounding in the science and theory of electricity and magnetism and in electro-dynamics. This is accompanied and followed by electrical measurements and tests of all kinds, standardizing, methods of determining electrical units, economics of electrical distribution, electric transmission of power and electric motors, electric locomotives, electric lighting, dynamos, lamps, etc., photometry, management and care of batteries, telegraphy, telephony, electrolysis and electro-metallurgy. Important additions to the course are contemplated.

A large suite of rooms in Science Hall is devoted to laboratory work in electricity, in immediate connection with the physical laboratories and lecture-room. The laboratory is well supplied with instruments and apparatus.

Reports of Companies.

EUROPEAN ELECTRIC WELDING CO.

THE late rise in European Electric Welding stock was probably due to the advance payment Aug. 25 of £5,000 of the purchase price of the English rights by the City of London Contract Company. The payment was not due until Sept. 1. There remains £20,000 to be paid, and it is due by Nov. 1. It may be paid by Oct. 1. The English company has brought out its prospectus, and subscriptions close to-morrow. Its capital stock is $2,300,000, par $50. It comprises 45,000 ordinary shares and 10,000 founders' shares, of which the European Electric Welding Company received 8,333 ordinary and 400 founders' shares, beside $527,795 cash. One million dollars in capital stock and $242,695 cash are to be put in the treasury for working capital. Options maturing Sept. 1 have been extended to Oct. 1 for electric welding rights in Germany, Austria-Hungary, Russia, Scandinavia, Denmark, Belgium and Switzerland on terms similar to the English terms.

Society and Club Notes.

STREET RAILWAY ASSOCIATION, OF NEW YORK.

THE ninth regular (annual) meeting of the Street Railway Association, of the State of New York, will be held at the Hotel Metropole, Broadway and Forty-second street, New York City, on Tuesday, September 15th, 1891, at 10.30 o'clock A. M.

A special committee has been appointed to present a report at this meeting on the subject of "Electric Motive Power for Street Surface Railways," electricity being the leading topic of interest in the street railway community. It is expected that the discussion following the report will develop the very latest information obtainable on the subject. Entertainment will be provided for the delegates, and every company in the State is urged to be represented.

Obituary.

MR. C. G. MERIWETHER, the superintendent of the Southern division of the Western Union Telegraph Co., with headquarters at Mobile, Ala., died on Aug. 29. He had held the position for several years and was well known in the telegraphic field.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED SEPTEMBER 1, 1891.

Alarms and Signals :—

Annunciator, W. C. Dillman, 458,947. Filed May 6, 1891.

Clocks :—

Synchronizing Mechanism for the Second Hands of Clocks, H. Munson, 458,716. Filed March 3. 1891.

Conductors, Conduits and Insulators :—

Electric Subway, J. C. Reilly, 458,778. Filed May 19, 1891.
Provides a method for leading wires or cables into a slotted conduit.

Distribution :—

Electro-Chemical Transformer, T. D. Bottome, 458,652. Filed Jan. 28, 1890.
Designed for the production of direct continuous currents from alternating currents without the use of magnetic devices or mechanically moving apparatus.

Dynamos and Motors :—

Regulator for Constant Current Dynamos, E. P. Clark, 458,617. Filed Oct. 4, 1890.
Employs a ring-shaped electromagnet having consequent poles, and journaled at its centre, for actuating the regulating device.

Constant-Current Dynamo, E. P. Clark, 458,618. Filed Oct. 4, 1890.
Rotates the diameter of commutation instead of rotating the brushes. Employs deflecting magnets acting upon the armature to vary the position of the diameter of commutation.

Electric Motor, E. Thomson, 458,646. Filed Feb. 2, 1887.
Designed to secure self-regulation or constant speed in constant-potential motors. Employs supplemental coils of low resistance upon the pole-pieces of the field-magnets.

Automatic Cut-Out for Dynamo-Electric Machines, S. H. Short, 458,666. Filed Oct. 29, 1889.
With a compound-wound dynamo employs a cut-out electromagnet in the external circuit and a circuit making and breaking device in the shunt circuit of the dynamo controlled by the electromagnet.

Electric Generator, J. C. Henderson & F. Sargent, 458,702. Filed June 21, 1890.
Combines upon a common supporting base, built up in sections, a steam engine and two dynamos, one on each side of the engine, and having their rotating portions directly attached to the engine shaft.

Armature for Electric Motors or Generators, J. F. McLaughlin, 458,856. Filed May 26, 1891.
Comprises a laminated iron body having a circular series of channels near its outer edge and an armature coil section housed in each channel.

Circuit-Controller for Electro-Magnetic Engines, C. J. Van Depoele, 458,869. Filed Feb. 3, 1891.
For use upon reciprocating motors.

System of Supplying Current to Reciprocating Electric Engines, C. J. Van Depoele, 458,870. Filed Feb. 26, 1891.
Motor has sets of coils energized by currents of different character. It is supplied from a source of continuous current. Means are provided in the vicinity of the motor for dividing such continuous current into alternating currents and intermittent currents of continuous direction and of supplying them to the different sets of coils in the motor.

Electro-Magnetic Reciprocating Engine, C. J. Van Depoele, 458,872. Filed Mar. 19, 1891.
In a reciprocating motor having a number of coils and an iron envelope surrounding them, employs a magnetic shield or shields interposed between a portion of the coils and the surrounding envelope.

Combined Electric Engine and Pump, C. J. Van Depoele, 458,873. Filed March 27, 1891.
A reciprocating motor combined directly with a pump.

Reciprocating Electric Engine, C. J. Van Depoele, 458,874. Filed April 7, 1891.
Combines the employment of an intermittent continuous current and an alternating current in the same motor, a separate coil being provided for each current.

System of reciprocating Electric Engines, C. J. Van Depoele, 458,954. Filed Sept. 19, 1890.
Improvement upon the invention patented to the same inventor November 11, 1884, No. 307,884.

Electire Motor, N. P. Otis & R. C. Smith, 458,976. Filed July 31, 1890.
Especially adapted for the service of elevators and relating specially to the method of starting and operating; which consists in passing the current through all the coils of the armature to render them effective on starting, and subsequently short-circuiting a portion of the coils when the motor is under normal speed.

Lamps and Appurtenances :—

Incandescent-Lamp Cut-Out, T. D. Bottome, 458,653. Filed March 16, 1891.

Carbon-Clamp for Electric Arc Lamps, A. P. Seymour, 458,718. Filed Jan. 3, 1889.
Clamp has a rigid V-shaped part on one side and a loose perforated V-shaped part on the opposite and a clamp screw passing loosely through the perforation of the loose part and seated in an extension from the opposite side of the clamp body.

Duplex Arc Lamp, B. B. Ward, 458,719. Filed Dec. 31, 1890.
A double-carbon lamp especially adapted for use on constant-potential circuits.

Electric-Light Fixture, F. H. Aldrich, 458,769. Filed April 17, 1890.

Electric Arc Lamp, B. B. Ward, 458,876. Filed Jan. 30, 1890.
Relates to focussing lamps.

Electric Arc Lamp, W. A. Turbayne, 458,987. Filed April 14, 1891.
Relates to devices for striking the arc and regulating the feed.

Measurement :—

Electric Meter, M. Koechlin, 458,755. Filed Oct. 16, 1890,
Employs the principle of the Wheatstone bridge and a resistance integrating apparatus.

Medical and Surgical :—

Electro-Therapeutic Apparatus, W. J. Herdman, 458,695. Filed Dec. 27, 1880.

Miscellaneous :

Fusible Cut-Out, C. S. Van Nuis & J. H. Vail, 458,608. Filed Oct. 16, 1890.
Employs a number of fusible wires arranged to be put in circuit successively and automatically upon the rupture of one of them. Includes a revolving drum and electric motor.

Lightning Arrester, J. P. Freeman, 458,656. Filed April 23, 1891.

Protective Fuse, H. V. Hayes & A. C. White, 458,753. Filed May 25, 1891.

Method of and Apparatus for Determining the Temper of Steel, C. A. Casperson, 458,784. Filed Oct. 7, 1890.

Electric Coal-Mining Machine, C. J. Van Depoele, 458,868. Filed Oct. 3, 1890.
A gang drilling or cutting machine actuated by an electric motor.

Electric Switch, A. Wissler, 458,879. Filed June 22, 1891.

Casing for Electric Switches, A. Wissler, 458,880. Filed June 22, 1891.

Phonograph, E. Oxley, 458,916. Filed Nov. 12, 1890.

Electric Comb, J. M. Riley, 458,952. Filed May 1, 1891.

Electric Comb, J. M. Riley, 458,953. Filed June 22, 1891.

Testing-Switch for Electric Circuits, R. C. Smith, 458,961. Filed Dec. 10, 1890.

Cleat for Electric Wires, H. P. Ball, 458,964. Filed Apr. 17, 1891.

Safety Device for Electric Elevators, N. P. Otis & R. C. Smith, 458,977. Filed Dec. 31, 1890.
Devices by which the operator in an elevator car or cage can arrest, reverse or vary the speed of the motor.

Railways and Appliances :—

Electric Railway System, W. H. Knight, 458,582. Filed May 11, 1886.
Employs a number of generators connected respectively to successive sections of an electric railway; provides means for reducing the current of any generator at the instant when a locomotive is leaving the corresponding section of road.

Electric Railway, W. H. Knight, 458,583. Filed Mar. 18, 1886.
Employs a slotted conduit on one side of a track; in a double-track line both conduits are between the two tracks; upon curves arranges the conduit somewhat eccentric to the curve of the track for convenience with respect to the contact device at the end of the car.

Electric Motor Truck, W. H. Knight, 458,584. Filed Mar. 5, 1889.
Motor is fulcrumed upon the axle and extends down between the wheels outside of the axle; frame bars counterbalance the motor upon the opposite side of the axle; includes a compression brake sliding on the frame bars.

Electric Brake, J. C. Lincoln, 458,587. Filed Feb. 24, 1891.
For electric railways. The motor is employed as a brake by using it as a dynamo.

Conduit for Electric Railways, F. E. Degenhardt, 458,619. Filed Nov. 21, 1890.
Designed to provide for security of insulation and for adequate drainage. Conductor carrying boxes are supported within a drainage conduit.

Electric Trolley or Contact Wheel, F. E. Degenhardt, 458,620. Filed Nov. 21, 1890.
Especially adapted for use with a fixed underground conductor.

Conduit for Electric Railways, E. E. Keller, 458,680. Filed Nov. 21, 1890.
Improvements upon the conduit patented to F. E. Degenhardt, No. 458.619. See above.

Electric Railway, H. A. Seymour, 458,665. Filed May 5, 1891.
Employs but one conductor for a two-track line. The overhead conductor is placed between the two tracks; the trolley poles are arranged to incline laterally to the conducting wire from a car on either track.

Electric Locomotor, H. F. & G. P. Shaw, 458,729. Filed Oct. 27, 1888.
Motor is mounted with its armature shaft longitudinally of the car; motion is transmitted to the car axle through a pair of rollers and friction gear.

Electric Railway Conduit and Contact Device, W. H. Knight, 458,747. Filed May 10, 1888.

Self-Lubricating Electric Trolley, T. Driscoll, 458,785. Filed Dec. 12, 1890.

Electric Car Mechanism, W. E. Badger, 458,800. Filed Oct. 17, 1890.
Consists of gear and clutch mechanism; armature shaft mounted longitudinally of the car.

Electric Railway, L. O. Dion, 458,844. Filed Nov. 24, 1890.
Discards continuous longitudinal overhead conductor. Substitutes a series of rigid supports at intervals along the side of the track and extending laterally over the track and carrying branch conductors from a main conductor underground; the rigid supports present points of contact to a conducting attachment on a car, made of such length that when it has separated from one of the fixed branches its forward end will have engaged with the next one.

Method of and Apparatus for Operating Electric Railways by Dynamic Induction, E. E. Ries, 458,859. Filed May 17, 1887.
Claim 1 follows:
The method of propelling vehicles by the agency of electricity by causing alternating or intermittent currents on a line or lines of conductors extending along a railway to induce alternating currents in a circuit or circuits feeding one or more propelling electric motors.

Closed Conduit for Electric Railways, C. J. Van Depoele, 458,866. Filed Feb. 8, 1887.
Contact devices connected to the car effect contact with the insulated conductor in the conduit at intervals by means of electro-magnetic devices and pins extending through the wall of the conduit.

System of Electric-Railway Conductors, C. J. Van Depoele, 458,867. Filed July 19, 1889.
Employs an exposed working conductor or conductors, a conductor insulated from the working conductor or conductors; the insulated conductors forming closed circuits in inductive relation to the working conductors; grounded connections extend from such closed circuits. Designed to prevent inductive disturbance upon other electrical conductors in the vicinity of an electric railway.

Telpher System, C. J. Van Depoele, 458,871. Filed Feb. 28, 1891.
The track has a lower supporting or traction rail, an upper grooved guide rail, lateral guide rails, and frames surrounding and sustaining all the rails in fixed relation. The car body is cylindrical and spring supported within a wheeled frame.

Electric Railway, W. C. Wright, 458,931. Filed Nov. 25, 1889.
Relates to the construction of a conduit and to the contact carriage.

Electric Railway, W. C. Wright, 458,932. Filed Nov. 29, 1889.
Relates to improvements in the contact carriage.

Controlling Dynamo-Electric Machines for Electric Railways, S. H. Short, 458,956. Filed April 30, 1890.
To prevent the overloading of the dynamo and the production of an excessive current.

Telegraphs:—

Telegraphy, D. Kunhardt, 458,585. Filed Mar. 26, 1891.
An arrangement of apparatus and of circuits permitting the use of either direct or alternating currents.

Appointments, Etc.

MR. DAVID N. COOK, of the Essex, Mass., electric street railroad, has resigned for the purpose of taking a position in a railroad equipment company.

MR. S. A. SOUTHWICK, formerly of the Sprague and Thomson-Houston Companies, has been appointed electrician of the Essex Electric Co., of Salem, Mass.

MR. PAUL RUSTLING has been appointed general superintendent of the electric railway at West Bay City, Mich., to succeed Mr. H. H. Applin, resigned.

MR. P. A. SMITH has been appointed manager of the Ellsworth, Me., Electric Illuminating Co., to succeed Mr. F. S. Palmer, resigned.

MR. G. N. BLOSE, lately the manager at Newcastle, has been appointed manager of the Postal Telegraph Co. at Youngstown, Ohio.

SUCCESS OF ELECTRIC LAUNCHES ON THE THAMES.

FROM information furnished by Messrs. Woodhouse & Rawson, the number of launches on the upper reaches of the river is constantly on the increase. They are now almost as familiar to those who use the river as steamboats, and certainly regarded with less of loathing. Woodhouse & Rawson, to meet the requirements for these boats at regattas, have built a floating charging station. In appearance it is very similar to a house boat. The charging station consists of a river barge, 80 feet long and 14 feet beam. The machinery is placed in a compartment at one end, and consists of a semi-portable steam engine plant and dynamo of sufficient output to charge the accumulators on six launches simultaneously. The remaining portion of the boat contains a storeroom, an office, sleeping apartments for the attendants, and an engineer's room, where a lathe is fixed, and attendants are kept constantly in readiness to effect any repairs to launches which may be required, a convenience boat owners know how to appreciate.

THE STANDARD ELECTRIC CO.

THE above-named company, of Detroit, Mich., are engaged in the manufacture of a perfected storage battery, constructed upon different principles from those made heretofore and which possesses, in a high degree, all the points of durability so much to be desired in a commercial battery. It is so constructed as to be entirely free from active material falling out, short-circuiting and buckling, and can be charged and discharged at any required rate without depreciation or injury of the plates or loss in efficiency; this especially adapts it for street railway work, in which capacity it is in practical use with very satisfactory results. The battery is manufactured under the Logan patents, which, it is stated, are entirely fundamental and do not conflict in any point with those of other manufacturers. This battery is causing a great deal of interest, particularly from the fact that expert care is unnecessary with it, as it practically takes care of itself.

OKONITE.

THE International Okonite Co. has just issued a new price list, No. 5, of its insulated wires and cables for all classes of service. It is well classified and full of useful information and data. We notice a page devoted to railway span wire, and a line of Okonite soft tubing made from the regular Okonite compound.

THE WOOD ARC LIGHT SYSTEM.

THE Fort Wayne Electric Co. has just issued a list of sales of the Wood arc light apparatus made from November 1, 1889, to August 1, 1891. The total reaches no less a figure than 20,180 lights, and the list is a remarkable exemplification of the popularity of the Wood dynamo and lamp.

THE KEYSTONE ELECTRIC CO. have just sold a five h. p. motor to the Erie Piano Co., and a two h. p. motor to a pattern shop in Erie, Pa.

RIES ELECTRIC SPECIALTY CO.

THE Ries Electric Specialty Company have recently secured the handsome and commodious building on the northeast corner of Baltimore and Eutaw streets, directly opposite the Eutaw House, and have just fitted it up with the necessary machinery and appliances for manufacturing some of their electrical specialties. One of the first surprises this company has in store for its electrical friends has been in course of active preparation for some time past and will shortly be introduced to the trade and the public at large. It is asserted that the device referred to will create something of a revolution in incandescent electric lighting. A number of other appliances will also be placed on the market.

A STEAM APPLIANCES DIRECTORY.

WE are in receipt of a copy of "Hewling's Directory of Steam Specialties and Engineering Appliances," giving a complete classified list of all manufacturers of articles in this line. It will be found a very handy book of reference. It is published by A. J. Hewlings, 218 Lake street, Chicago, at $1.

RAW HIDE PINIONS.

THE New Process Raw Hide Co., of Syracuse, N. Y., have the following from the Wilkesbarre and West Side Railway Co.: "We have been using your raw hide armature pinions for over a year, and find them the best and most durable pinion that we can buy."

A "UNIQUE SPECIAL SUPPLEMENT."

THE Boston *Herald* of August 16 has the following: "THE ELECTRICAL ENGINEER of August 12 prints a most unique special supplement of about 20 pages, illustrative of the extensive Edison light and power industries as existing to-day, and as compared with their humble beginnings 10 years ago. It is splendidly illustrated, and makes suggestive reading. It is apropos, too, in view of the fact that the Association of Edison Illuminating Companies held its annual meeting in New York City during the week."

THE COBB INSULATING PATENTS have been sold in Philadelphia at auction by M. Thomas & Sons. The patents were granted to Henry B. Cobb, numbered 288,310, 288,311, 293,632, 294,365, 330,-873, 330,874, 396,548, 408,374, 408,375, 406,376, 406,377, 429,304, 429,-305, 429,306, 429,307, 429,292, 440,395, 451,614, 452,517; also a certain invention and patent to be obtained therefor as follows, to wit: "A method of and machine for manufacturing insulated electric conducting wire," as described in an application filed in the United States Patent Office by Henry B. Cobb, May 29, 1890, serial No. 353,561; also foreign patents that were granted to Henry B. Cobb by Austria, Italy, Belgium, England, France, Germany and Canada. The above patents were bought by James C. Stillwell, attorney, No. 727 Walnut street, for $100 each.

A PRETTY TOUGH FILAMENT.—During a recent visit to the New York and Ohio Company's incandescent lamp factory, at Warren, O., some very remarkable tests of the durability of the Packard lamps were witnessed. A 50 volt lamp picked up hap-hazard from a barrel of lamps was taken and run first at 90 volts, measuring on the photometer 200 c. p., and absorbing 2 amperes for a period of 15 minutes; at the end of this time there was absolutely no perceptible discoloration. The voltage was then raised to 120 volts, the candle power being probably 600 and the current 2½ amperes. But the end was not yet, as the filament would not break, and it was only when the connecting wire to the platinum leading-in wire melted apart at the soldered joint that the current was turned off and the lamp taken down somewhat blackened, but still in the ring, and the filament perfectly intact. The lamp was then broken and the filament removed and bent double once or twice with the fingers, and seemed to be tougher than ever. Mr. Packard says that such tests with his lamps are frequently made, and, in fact, the lamps seem to like them. The sceptic may be inclined to regard these statements as mendacious; if so, let him go there and see it done and he will come away an astonished believer; or let him take a Packard lamp and make the experiment himself.

THE NEW ELECTRIC LIGHT PLANT for the Pawtucket Gas Co., at Pawtucket, R. I. will be very substantial. The dynamo-room will be 60x150, the engine-room 58x78 ft., and the boiler room 60x60 ft. The side walls will be of brick, with iron roof-covered with corrugated iron. The whole plant will be built by The Berlin Iron Bridge Co., of East Berlin, Conn., after the plans and specifications of Remington & Henthorn, engineers and architects, of Providence, R. I.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Advertising is to business what steam and electricity are to machinery.

THE ACME LEAD CABLE.

THIS is one of the latest products of the International Okonite Company (Limited), New York and London. It is a lead-covered cable and designed for extra heavy work and high voltage under extremes of temperature, being especially adapted for underground work. A special feature of the new cable is its thorough insulation, which consists of a combination of two or more distinct insulating materials, possessing different valuable qualities; one, of the high electrical resistance of Okonite; the other, an improved rubber compound especially adapted to resist the effects of high temperature. The high insulating properties of Okonite are well known to the trade. The special rubber compound, which also possesses high insulating and waterproofing qualities, has the additional quality of not being sensitive to heat. Its application serves as a protection to the high grade Okonite insulating material beneath, and insures centralization of the conductor at high temperature. In other words, it does not soften, neither does it allow the conductor by its weight to sag down through the insulating materials. After this second layer is applied, the cable, thus far made, is run through a bath under high heat until the insulation becomes impregnated with a material which protects it thoroughly from the effects of gas and moisture.

Over these two layers of special insulating material is superimposed a braid which in its turn is saturated with the same material to prevent capillary attraction to the exposed ends of the cable and protect it from the rotting effects of gas, and to increase lasting qualities, making it a most durable braid.

Though more expensive, the manufacturers use a braid in preference to a tape, on account of its superiority. Being elastic, it does not break on bending, as the tape is sure to do, but gives readily.

The now practically finished cable is then lead-covered by the most improved hydraulic processes that have yet been introduced, insuring freedom from blow holes and air bubbles, and an even thickness and quality of lead. The lead is alloyed with tin, to secure sufficient hardness, and to resist abrasion in drawing through ducts, yet assuring sufficient ductility to enable the cable to be easily handled without rupture.

THE HANSON PRIMARY BATTERY.

A NOVEL form of primary battery intended for use in supplying light and power in private dwellings has recently been devised by Mr. Walter Hanson, of Washington, D. C., and is shown in the accompanying illustrations. Here, Fig. 1 shows a vertical sectional view of the battery, while Fig. 2 is a plan of two cells, showing Mr. Hanson's method of connecting them.

The earthenware jar A has suspended in it a porous cup, C, by means of a wooden frame, B, so that the solution in the jar may come into close contact with both the bottom and sides of the cup. The carbon plates D are suspended in this cup, and are separated at their upper ends by a wooden strip, E. The sides and tops of these carbons are electroplated with copper, and are connected by the copper band F bent to form a triangular loop with the sides of the carbons and the end of the wooden strip between them.

The zinc plates G have secured to their upper ends the bent wires *g* and *h*, by means of which they are suspended in the jar.

Two solutions of different strength are used in the battery, the stronger being placed in the porous cup C, while the jar A is filled with the weaker solution, which surrounds the bottom and sides of the cups.

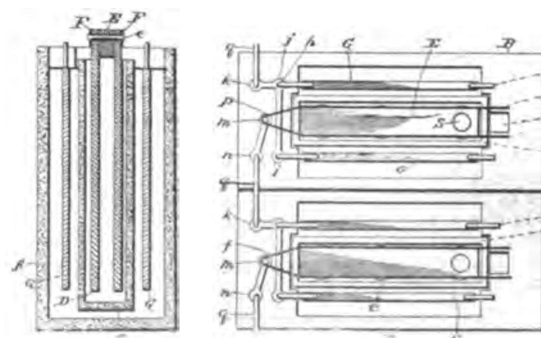
The two solutions are not, therefore, united, but the porous cup acts as a conductor between them, and thus increases the action of the battery.

In one end of the frame B, beneath the cap *b*, there is set into the frame a series of mercury-cups for concentrating the currents and providing attachment for the poles when a single battery is used, or for attachment of the electrodes when it is desired to use a series of batteries.

The frame B is cut out to receive these mercury-cups and their connecting-bars, and they are driven into the frame and covered by the cap *b*, which keeps them securely in place. This cap is provided with holes, *c*, which register with the mercury-cups. The wires *h* are bent in the form of a staple, one end being attached to the zinc plate and the other end passing through the cap and entering one of the mercury-cups. In the apex of the triangle *f* of the copper band F there is a copper pin, *p*, which is soldered to the band, and enters one of the mercury-cups. It will be seen that the wire *h* of one of the zinc plates enters the mercury-cup *i*, and that the wire of the other zinc plate enters the mercury-cup *j*, thus connecting the two zinc plates, while the pin *p* of the negative electrode enters the mercury-cup *m*.

Two holes are shown at R and S respectively. These are for the purpose of filling the jar and cup without removing the electrodes.

The Hanson Battery, Light & Power Co., of 514 8th street, N. W., Washington, D. C., has been placing these batteries with Elektron motors in houses, restaurants, saloons, etc., since the middle of May with great success, having now over 100 such installations out. It not only installs, but maintains, for a fair consideration. Some idea of the quality of its work may be found from a letter to Mr. Frank Aldrich the manager, from Major W. F. Tucker, of the U. S. A. Pay Department, as follows: "Last week the motor was given a pretty good test, and, I wish to say, was satisfactory in every way. You should be able to place a great many of them as they become better known." Mr. Aldrich has a set of 33 cells at his private residence, running 18 lamps of 50 volts. At an average, 10 of these lamps are run every night for three hours. The batteries are charged once in



FIGS. 1 AND 2.—HANSON PRIMARY BATTERY.

four weeks. Eight of the batteries are also connected up to run a pump, which lifts 150 gallons an hour a distance of 60 feet. This pump is also connected with a fountain in the front lawn, and thus a steady circulation is kept up. Mr. Aldrich is now getting up an equipment ordered for a boat on the Potomac, 18 feet long, to be driven by a two h. p. motor; and he is also getting ready for a trial of the batteries in street car traction.

THE LEFFEL WATER WHEEL PAMPHLET.

THE new pamphlet published by James Leffel & Co., Springfield, O., hydraulic and mechanical engineers, and makers of the James Leffel water wheel, is elegantly printed on finely finished paper, is handsomely illustrated throughout, and contains a large amount of useful and practical matter for those improving water power. A great number of plans for placing wheels are shown, both upon upright and horizontal shafts. Entirely new tables of wheels are published, containing features never before published.

This firm has been making the James Leffel water wheel for 30 years continuously, and its business is conducted by the same persons and managers that have been with it since its early history. They make 110 different sizes and styles, have shops, tools and patterns designed exclusively for this business, and are turning out more and better work to-day than at any time heretofore. The new pamphlet will be sent free to any one applying to the above address.

GREAT WESTERN ELECTRIC SUPPLY CO.

MR. THOMAS C. RAFFERTY, who for some time past has been in charge of the railway department of the Great Western Electrical Supply Co., has now been appointed assistant general manager of the company, which is doing a good share of the supply business of the West and enjoying a growing trade. Mr. Rafferty assumed his new duties September 1st.

MR. G. M. ANGIER, who has been connected for about a year with the Great Western Electric Supply Co. and has had charge of the lighting and other special departments, and who, previous to this, was with the Thomson-Houston Co., at St. Paul, has resigned his present position and accepted the assistant managership of the Knapp Electrical Works, Chicago. Mr. Angier is a young man, active and energetic, and has a host of warm friends among the electrical fraternity, who will be interested to learn of his new connection and wish him the success he will undoubtedly achieve.

THE WARD ARC LAMP.

THE Electric Construction & Supply Co., of 18 Cortlandt street, manufacturers of the Ward arc lamp for incandescent circuits, have just issued a very fine and well-written catalogue on their apparatus. As our readers are no doubt well aware, the practice of combining arc lamps with incandescent circuits has now become quite general. In fact the day is not far distant when an incandescent circuit without such lamps on it will be a rarity. There are a great many places where only the incandescent service exists yet where arc lamps are badly needed, and it is for just such places that the Ward lamp has been specially designed. It has now been perfected in many details, and includes various forms, the principal of which are the regular circuit lamp for ordinary work; the search lamp, the railway lamp, the theatrical lamp, the alternating lamp and the photo-engraving lamp. As to the street lights, some interesting quotations are made from the proceedings of the Edison Convention in 1890, when New York reported the use of 250 of them, Brooklyn 360, and Boston an equally large number, while since that time there has been a great growth. The railway lamp is provided with an automatic cut-out to throw into the circuit a resistance equal to that of the lamp. The alternating lamp is now furnished of the same general appearance as the continuous for use on circuits of low potential, running on 50 volts from the secondary. The engraving and theatrical lamps are of neat design and of simple construction. The search light is of easy manipulation, and made to stow away when not needed. One type for river and inland use can be mounted on top of the pilot house, with a shaft extending through to the interior, by means of which a wheel is fastened to it for revolving, raising or lowering the light, and the connections are such that the light can be revolved any number of times independently of the wires carrying the current.

The company supplies also resistance coils, lamp hoods, etc. The pamphlet, which is well illustrated, is supplemented by a number of testimonials. One from Brooklyn states that there are now in use in that city no fewer than 740 Ward lamps on the Edison circuits, giving great satisfaction. The Holland, Mich., Co. write that all their customers were wanting to change their incandescent lamps and get the arcs.

THE INTERIOR CONDUIT CO. AT MONTREAL.

THE Interior Conduit & Insulation Co., of New York, will be ably represented at Montreal by its general manager, E. W. Little, and E. T. Greenfield, electrician. As usual the company will present a complete exhibit of their admirable and now generally adopted system of electric wiring. This being the first opportunity presented since they have embarked in the general electrical manufacturing business to make an exhibit of their new appliances and apparatus, it is expected and promised that many new and novel devices will be shown, including several that have been exclusively described in THE ELECTRICAL ENGINEER.

The Johnson ampere meter, an absolutely "dead beat" instrument, and the Johnson vice lock switch will be found to be worthy of attention.

The company also promise to show the new "California" arc lamp, which they are about to place upon the market. This lamp is only fifteen inches in length, has no obstruction underneath, consequently casting no shadows, and will burn over 90 hours without trimming or change of carbons. For economical and other recognized advantages this new departure in arc lamps will be worthy of special attention from those visiting the exhibition.

The Garland carbon protector is another device that is promised to be shown. This device will be found specially useful in enabling the users of the single-carbon type of lamp to enjoy all the advantages of long life of carbons, hitherto only accomplished by the use of double-carbon lamps. It is claimed for the Garland carbon protector that it is effective in decreasing the consumption of the carbons from one inch and a half to one-half inch per hour.

Other useful and novel appliances especially applicable to the conduit system will be shown.

A PIECE OF WRAPPING PAPER.

"ONLY a piece of wrapping paper, but there's a thought wrapped in it for you," is the legend printed on a bit of coarse paper. Opening this as one does naturally, we find the announcement of the Jenney Electric Motor Co., of Indianapolis, Ind., together with the statement that the Jenney motor is the best made. It is an ingenious little scheme of advertising, and likely to prove effective.

CABLE RATES.

THERE has been a good deal of talk in the newspapers as to an advance in cable rates, the overtures having come from the Anglo-American Co. to the Mackay-Bennett (Commercial) Co. This is denied, and Mr. W. H. Mountford says that the Anglo Co. has made no such proposition, while the Commercial people say that they are quite satisfied with the money they are making at 25 cents a word.

WESTON ELECTRICAL INSTRUMENT CO.

IN the way of voltmeters and ammeters it would be difficult to find more popular goods than those manufactured by the Weston Electrical Instrument Company, of Newark, N. J. They have been adopted as standards by nearly every large company engaged in the manufacture and sale of electrical instruments in the United States. The demand for them continues brisk.

NEW YORK NOTES.

CHAS. A. SCHIEREN & Co., manufacturers of the famous patent perforated leather belting for dynamos and other swift-running machinery, are making extensive alterations in the appearance and appurtenances of their offices and salesrooms, 47 Ferry street, New York. Their quarters will be very inviting as well as convenient when the changes being made are completed.

THE FISHKILL LANDING MACHINE CO., Fishkill-on-the-Hudson, N. Y., manufacturers of the Fishkill-Corliss engines, horizontal and upright, are experiencing a steady demand for their specialty. With their latest styles of valve-gear and noiseless dash-pots, these engines are bound to enjoy a high degree of popularity. They are very attractive in appearance, and are efficient and durable.

ABENDROTH & ROOT MANUFACTURING CO., 28 Cliff street, New York, manufacturers of Root's improved steam boiler, find the demand for it steadily increasing. They are very busy at present and the outlook for the balance of the year is exceedingly promising.

THE INTERNATIONAL OKONITE COMPANY, LIMITED, New York and London, find business brisk, especially in their cable department. The Acme lead cable for underground purposes, recently brought out by this firm, promises to become very popular.

WESTERN TRADE NOTES.

THE FOREST CITY ELECTRIC WORKS, of Geneva, O., are shipping large numbers of the well-known Cleveland Arc Cut-Outs and constantly receiving new orders. The satisfaction they are giving is well shown.

Some quotations from recent correspondence: "We have been using the Cleveland Arc Cut-Out during the past six years with great success. We consider them safe and reliable in every respect." (From Brush Electric Light and Power Co., Cleveland, O.) "We have used your Arc Cut-Out for a number of years almost exclusively. We have found it very satisfactory in every respect." (From Detroit, Mich., Electric Light & Power Co.) "We have over seven hundred (700) of your Arc Cut-Outs in service and are pleased with them." (From Brush Electric Light Co., Rochester, N. Y.) "We are pleased to say that we have used your Arc Cut-Outs for the past two years and with good results." (The Toledo Electric Co., Toledo, O.)

THE JAMES LEFFEL & Co. have just sold the Niles Electric Light & Power Co. three 4½ feet Leffel wheels with all of the shafting, gearing and transmitting machinery for operating their plant there. They are also building a 400 h. p. wheel for the Edison Illuminating Co., in Rochester, N. Y. The Rochester Power Co. have just started a 500 h. p. wheel 30 inches in diameter, with new patented gate arrangement which is working very satisfactorily. A 5½ foot wheel is almost ready for shipment to Goshen, Ind., for electric lighting service. C. P. Poole, Lynchburg, Va., has bought a 5 foot wheel for electric lighting.

THE BUCKEYE ELECTRIC CO., of Cleveland, O., manufacturers of incandescent lamps, have issued a very handsome little catalogue of their lamps. It is beautifully illustrated, and the frontispiece, showing the various sources of artificial light from Father Time with a torch, through the era of candle, oil and gas, to the incandescent lamp, is exceeingly pretty and appropriate.

THE SIOUX CITY GAS LIGHT CO., of Sioux City, Iowa, are making some extensive changes in their power plant, and will put in two large Armington & Sims engines. This company has been using a 400 h. p. engine of this make for some time past. The Pond Engineering Company, of St. Louis, have the order for this additional work.

E. F. VAN NESS & Co., of Valparaiso, Ind., have arranged to install an electric lighting plant, and have purchased their machinery, including two steel boilers and an Armington & Sims engine. This order was placed with the Chicago office of the Pond Engineering Company.

WARRELL FUSE-BLOCK.

Warrell Fuse-Block.

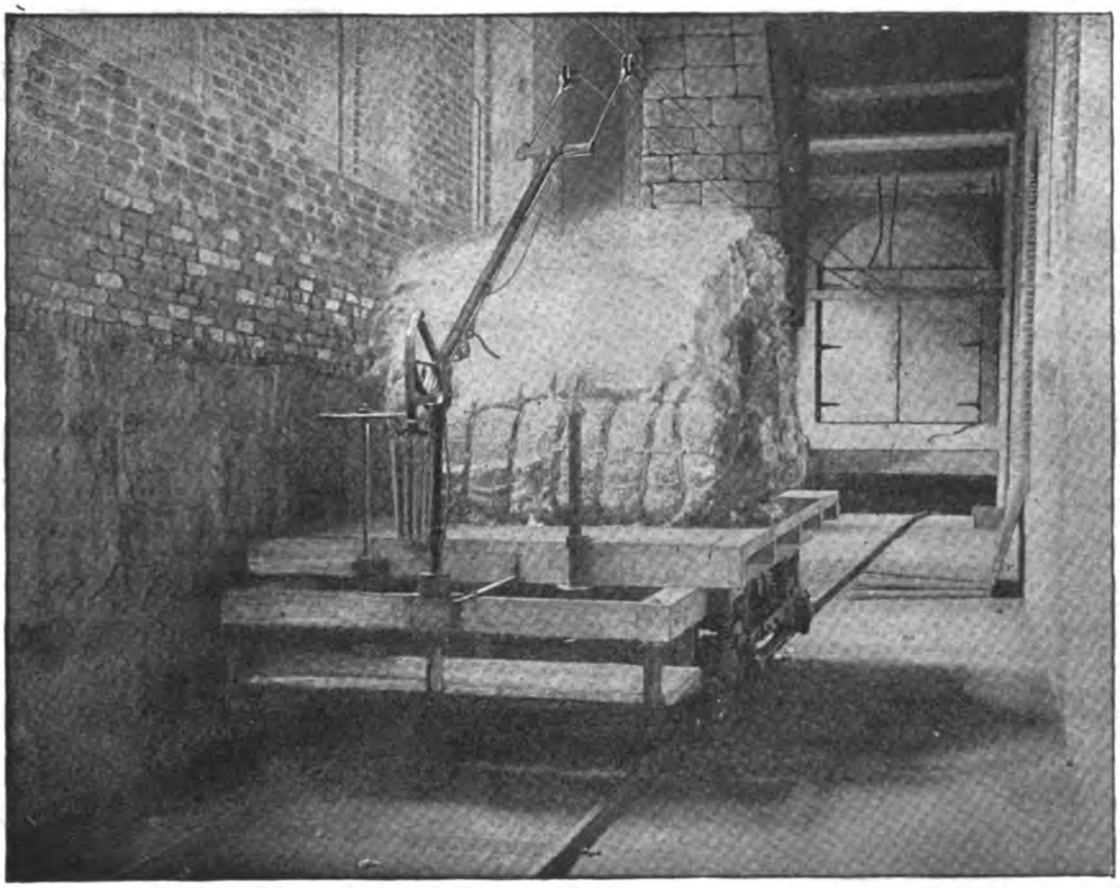
THE illustration herewith shows a single-pole fuse-block recently invented by Mr. Fred. G. Warrell, of Philadelphia. These fuse-blocks are constructed of the best vitrified porcelain encased in a glass shell, thus rendering them moisture-proof. The shell, being transparent, gives the wireman a full view of the interior without taking it apart. They are very compact, being less than an inch long.

Mr. Warrell has also invented a double-pole fuse-block of the same character, possessing the same advantages as the single-pole block, and only slightly larger.

ELECTRIC TRAMWAY, JACKSON MILLS, NASHUA, NEW HAMPSHIRE.

AN interesting example of the saving in time and money made by the use of electricity as a motive power for the handling of heavy materials in manufactories is shown in the plant recently installed by the Thomson-Houston Motor Co., of Boston, Mass., at the mills of the Jackson Manufacturing Co., of Nashua, N. H. The Jackson Company has for a number of years transported its cotton from the cotton house to the picker room by means of platform trucks running on rails, which were loaded with cotton and pushed along by men. When the motive power was changed to electricity the same rails were used and the road was equipped with a three horse power motor car. Instead of the six men formerly employed, two men do the entire work, thus accomplishing a great saving both in time and money. A wooden tunnel, the full length of the cotton house (300 feet), about eight feet wide by ten feet high, contains the track. About every fifty feet openings are made in the tunnel, from which the cotton is taken and loaded on the car.

The illustration shows the motor car with a load of cotton, near the end of the route. The iron doors seen at the end of the tunnel open into the picker room. The motor car is also employed as a locomotive for hauling coal from the coal sheds to the boiler room, which is situated at the right of the tunnel next the picker house. As will be seen by reference to the cut, the double-trolley system of wiring is used, thereby avoiding the use of the rails for the return circuit. The total length of the track is about 300 feet with a gauge of four feet. The road has a grade of 3 per cent., notwithstanding which loads of 4,000 pounds weight are easily handled by the motor car. The current is furnished by a 220 volt Thomson-Houston generator of the type known as D 7½, which also furnishes current for lighting the tunnel.



THOMSON-HOUSTON FREIGHT CAR AT NASHUA, N. H.

THE AKRON ELECTRICAL MFG. CO.

THE above-named company was organized in January, 1891, by prominent capitalists of Akron, O., for the purpose of forming a strong and pushing corporation for the manufacture of general electrical supplies, generating and power apparatus. The company has a paid-up capital of $100,000, and is well backed financially. Located as it is in the heart of one of the best manufacturing districts in the country, amply provided with the best railroad facilities, there is no limit to the extent and magnitude of its operations. The well-known Loomis Fire-Alarm System is manufactured by it. It is also placing on the market a complete line of stationary motors and generators, for both power and light uses, of perfected form and slow speed, with full power, high efficiency and unsurpassed mechanical construction. It will make a specialty with the stationary machine of the application of electricity to mining operations, and is prepared to take contracts for the complete mechanical and electrical equipment of mines of all kinds.

Mr. W. D. Chapman, general manager of the company, has had an extended experience in electrical street railway construction work, being one of the earliest contractors in that part of the country to equip street railways with electricity, and also has had about 15 years' experience in mining engineering, which eminently adapts him for the management of the company. The company will also build electric motors of improved type for street railway work and take contracts for the complete building and equipment of street railways, from the laying of the track to all of the details which comprise a first-class street railway plant. In this connection it will manufacture numerous specialties for overhead street railway construction.

The president of the company is Mr. F. A. Wilcox, who is also well known in street railway circles, in which he has large interests. The vice-president, Mr. E. B. Miller, is a prominent business man of Akron, where he is connected with the large reaper works of the Buckeye Mower and Reaper Co. Mr. Wm. B. Doyle, secretary and treasurer, is a capitalist of Akron. The field of operations of the company is large, but its adequate facilities will be handled in the most thorough manner, and it is the intention to do a large and general electrical manufacturing business for the installation of plants of any magnitude.

NEW STYLE ANDERSON TROLLEY WIRE HANGERS.

We illustrate two new forms of trolley wire hangers recently brought out by Messrs. A. & J. M. Anderson, and now being sold

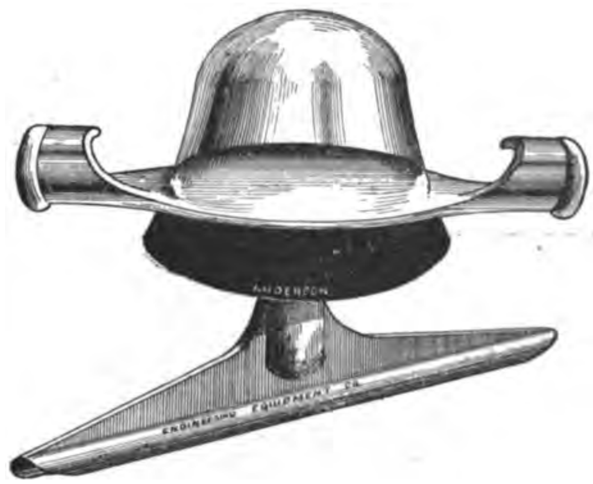


Fig. 1.—Anderson Trolley Hanger.

by the Engineering Equipment Company, of New York and Boston.

Fig. 1 shows a hanger which has met with a very favorable reception from constructing engineers and has the merit of bringing the trolley wire as near to the span wire as possible. Fig. 2 illustrates the second form, which has the much-used high support and permits the hanger to be readily sprung into place upon a tightly drawn span wire. We note a decided tendency, however, among many constructing engineers to bring the strain as much in line with the trolley wire as possible. The form shown in Fig. 2 was designed, therefore, to accomplish this aim and has been adopted by several engineers in their present work, as possessing advantages not to be found in other forms of hangers, in addition to being uncommonly compact and strong, and thoroughly reliable as regards durability.

Both these designs of hangers have the form of an inverted cup, with side arms for attachment to the span wire. The cup is filled with the standard Anderson compound, known as the Ætna insulating material, with a long petticoat extending beyond the metal, and a threaded brass fixture embedded therein, to which

Fig. 3.—Anderson Ætna Railway Bell Insulator.

any one of the numerous trolley clips or ears on the market can be readily attached. Brass alone is used for the metallic portion of the hanger, which effectually prevents the creeping over the insulation of the rusty film which sooner or later by oxidation occurs in hangers containing iron, thereby seriously impairing the insulation of the trolley wire. Altogether the new hangers are light, exceedingly strong and made to last, and several orders have already been placed. They have met with a cordial reception among constructing engineers who believe they will stand the test of time and fill the want of substantial materials for permanent overhead construction.

In Fig. 3 is illustrated the standard Anderson Ætna railway bell insulator, well known through the thousands now in use. The Ætna material is an exceptional insulating compound. It is moulded under a pressure of several tons to the square inch, does not crack or split when struck, is entirely unaffected by water, has stood boiling for hours without damage and will stand any amount of ill-treatment on account of its toughness and strength. It is especially adapted, therefore, for use as a reliable bell insulator, or in a similar form, wherein the weight of line and any strains must be borne by the material itself.

The Engineering Equipment Co., 143 Liberty St., New York, and 126 Pearl St., Boston, are the selling agents for the line

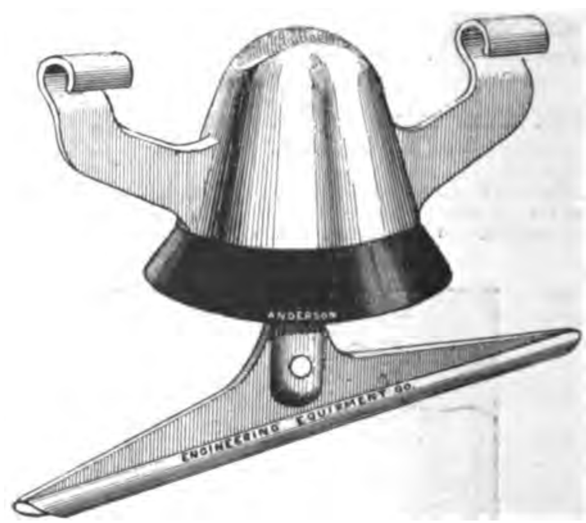


Fig. 2.—Anderson Trolley Hanger.

materials and the Boston trolley manufactured by the Messrs. Anderson.

THE GERMANIA SHADE-HOLDER.

Among recent electrical specialties, the shade-holder manufactured by the Germania Electric Co., of Boston, deserves more than a passing notice. The patent covering this simple device was issued in February, 1890, but with characteristic conservatism the Germania Co. has not pushed its sale before thoroughly testing it by extensive use. A large number of these shade-holders were put into use about two years ago, and they have given such uni-

Germania Shade Holder.

versal satisfaction that the company has determined to push them, and has made every endeavor within the last few months to place them on the market at the lowest possible price.

The shade-holder, as seen by the accompanying engraving, consists of two parts. Projecting from the under side of a main ring are three ears, through which screw-nuts are passed for holding the shade or globe in position. The upper part of the main ring is bent over and has three inwardly-projecting arms, which are hooked at the end in order to hold the second smaller ring in position. This small ring is simply a plain band of thin metal having two ears through which a screw passes, and is used for clamping the shade-holder to the socket or fixture.

A simpler or more efficient device could hardly be imagined. In making these shade-holders nothing but first-class metal is used, and the whole is highly finished, making a very light, stiff shade-holder, beautiful in design, and cheap. It will be noticed that there are no joints and no weak points, so that there is absolutely nothing to break and no part to work loose. It is in every respect a model shade-holder.

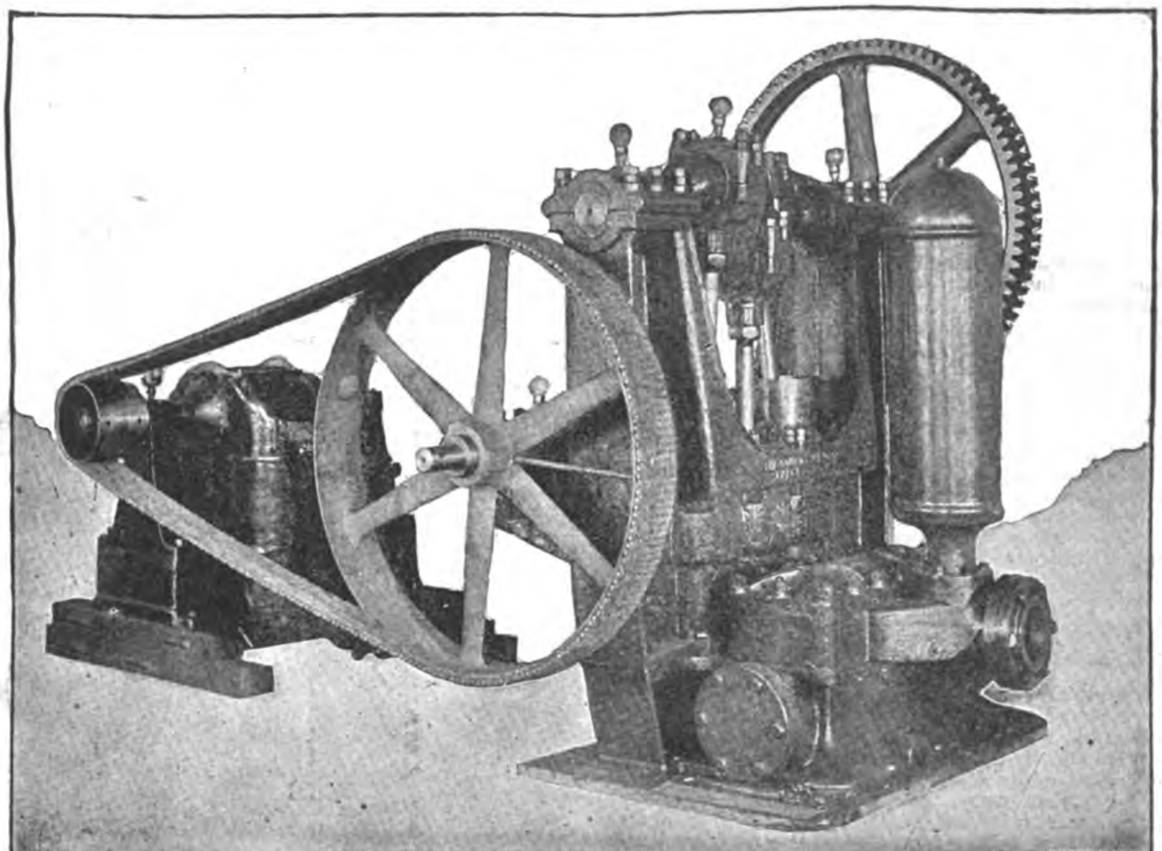
THE GOULDS "TRIPLEX" ELECTRIC PUMP.

THE general application of electricity for mine operation in lighting, operating fans, haulage locomotives, coal cutters, drills, etc., makes electric pumps only a part of the general system—nor should this item of pumping be under-estimated when the best authorities concur that on an average seven tons of water are pumped for every ton of coal mined. Heretofore, as is well known, this pumping has been generally performed with steam pumps, steam being generated at the surface and transmitted below for operating the pumps. With the electrical transmission pumping can be done at places where it has been impossible to operate the steam pump from the long distances which the steam must necessarily be conveyed, and because of the small space required by the electric pump in comparison with the large, cumbersome steam pumps generally used.

The Goulds Mfg. Co., of Seneca Falls, N. Y., has designed an electric pump especially for this class of work. One type of this pump, known as the "Triplex," is built with phosphor bronze bushed cylinders, glands and solid plungers of the same metal to resist action of sulphuric acid, usually encountered in mine pumping. The connecting rods are tied to the crank shaft by solid bronze bushed strap ends having adjustment for wear. The bronze suction and discharge valves on either side of cylinder are of a simple, yet heavy substantial pattern, best adapted for severe and continuous service. The construction of the pump admits of its being taken apart, which may be necessary, to carry it into a mine, and as readily put together for service. The pump is designed to operate against any pressure up to 800 feet lift.

Another form of "Triplex" pump is shown in the accompanying illustration, which has raw hide pinion and pulley for belt. This combination of pump and motor connected by a belt can be brought within surprisingly small limits, and is practically noiseless in operation. It readily commends itself also for house or office building service, where any noise is objectionable.

As will be noted, these pumps are operated by Thomson-Houston motors, and the results of an elaborate series of tetss made at the Thomson-Houston Works, at Lynn, Mass., showed that the 4 in. x 4 in. pump operated by a three h. p. motor developed an efficiency of 59.5 per cent., when operating under a pressure of 150 lbs. per square inch, that is, equal to a lift of 350 feet; while the 4 in. x 6 in. pump, driven by a five h. p. motor, developed an efficiency of 60 per cent. under like conditions.



THE GOULDS "TRIPLEX" ELECTRIC PUMP.

TESTS ON THE SHORT "GEARLESS" MOTOR.

DURING the past month the Short "Gearless" motor has been very thoroughly tested in Cleveland, being put to the hardest kind of work in regular commercial operation. Among some of the noteworthy tests are mentioned the following:

In order to prove the power of the motor, it was attached to two other motor cars and drew them without difficulty along a rough and dirty track, attaining a very fair rate of speed. The car was stopped at the commencement of a 40-foot curve, at the other end of which was a 8 per cent. grade. It was then started up, and without difficulty drew the three cars around the curve and up the grade. This was one of the severest tests which could be put upon the motor under all the conditions. A prominent electric railway manager who was present stated that not a single motor on his line could do the same work.

The car was put into regular service on three of the Cleveland street railway lines, hauling trail cars and drawing heavy loads without the slightest difficulty, and at speeds far in advance of the ordinary schedule of the road. Current and voltmeter readings were taken in each case, showing that the power consumed was even less than had been anticipated by the Short people themselves.

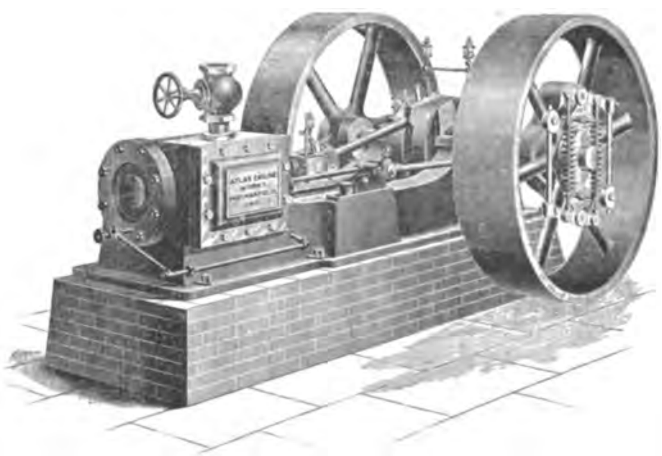
A comparative test was made on Tom Johnson's line between the "Gearless" motor, drawing a trail car, and one of the best-known of the "Single Reduction" motors now in the market, also drawing a trail car. The cars were run ten minutes apart over the same line for a distance of 22 miles, covering one round trip. This distance was made in two hours by both cars, stopping to take on and let off passengers. The fare register showed 80 passengers carried by the Short motor and 47 by the "Single Reduction." Ampere and volt readings were taken at intervals of one-half minute for a long distance, the general averages showing that the Short "Gearless" motor required about 25 per cent. less power than the S. R. G. motor. This was a complete surprise to all concerned, as the Short Company had hardly hoped to show any material advantage over other motors in the matter of current, its chief claim being for the "Gearless" a large reduction in the repair account, owing to the extreme simplicity of the machine.

In one of the tests the trail car ran off the track at a curve. Its brakes were set and it was drawn on to and around the curve with full load on both cars without the slightest difficulty.

ATLAS ENGINE WORKS.

THE accompanying illustration shows an automatic self-contained engine built by the Atlas Engine Works, of Indianapolis, Ind. This engine is designed especially for electric light and other work, where perfect regulation is necessary and high speed desirable; and is solidly built with long bearings and large pins.

A special feature of this engine is its governor, which, with few parts, combines the best points of governors of its type, and



THE ATLAS HIGH SPEED AUTOMATIC ENGINE.

has this additional feature, namely, that the weights being hung from the centre, the inertia of the whole is made to contribute in a very effective manner to the fineness of the regulation of speed. The eccentric is hung rigidly, is not liable to wear out of line, and is yet under perfect control of the weights and springs. The main steam valve is perfectly balanced, the only friction being due to its own very light weight. The balancing hood is loose on the seat and yields promptly to water or excess steam in the cylinder, while springs return the hood to its place, and studs guide it to its correct seat.

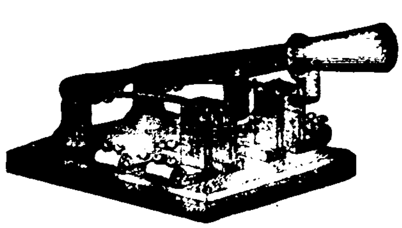
Altogether, the engine with its governor and valve forms a most attractive piece of machinery, perfect in regulation, economical of fuel, and reasonable in price.

The Atlas Engine Works have recently published a very handsome catalogue of their engines and boilers and accessories, together with complete specifications and directions for setting up.

THE WESTON QUICK-BREAK SWITCH.

THE illustration herewith shows a new "quick-break" switch recently invented by Messrs. W. H. Weston & Co., of Philadelphia. These switches are constructed of yellow or red brass, dipped or polished, and mounted on slate bases. The wearing parts are strong, durable, and easily replaced. The contacts are of ample proportion, capable of carrying a current in excess of rated amount. All arcing is prevented, as the breaking of the contact is done very quickly, no matter how slowly the handle may be raised.

The quick breaking is accomplished by means of a tempered steel spring. On raising the handle, tension is placed on the



WESTON QUICK BREAK SWITCH.

spring, and when the contacts are about leaving the clips the tension causes them to fly out, when there is no opportunity for the formation of an arc.

MR. T. T. ROBINSON, of Dedham, Mass., has been chosen treasurer of the Worcester, Leicester, and Spencer Electric Railway Company.

MR. HARRY WILLARD has been appointed superintendent of the Leicester, Mass., Electric Co.

THE STANDARD UNDERGROUND CABLE CO.

THE Standard Underground Cable Company will have an unusually handsome exhibit at the Montreal Electric Light Convention. Among other things it will consist of a double set of the company's initials done in brass, supporting samples of underground cables for all classes of electric service.

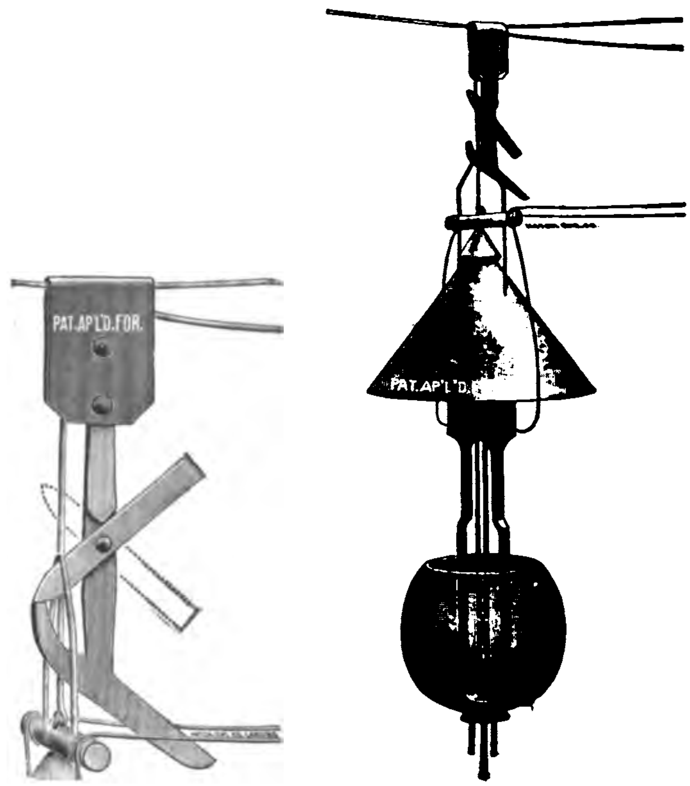
It will contain, also, a special sample board of samples of all the kinds and sizes of cables to be used in the contract of the Minnesota Brush Electric Light and Power Company, of Minneapolis, just awarded the Standard Company, and which covers over 400,000 feet of underground cable, making it the largest single contract of its kind ever given in the United States.

Vice-President J. W. Marsh, of Pittsburgh, and Manager G. L. Wiley, of New York, will represent the company at the Convention.

THE PADDOCK ARC LAMP HANGER.

THE cuts represent the action of the Paddock "Safety Arc Lamp Hanger" just being placed upon the market by the Central Electric Company, of Chicago.

This hanger is very simple in its construction, and is so well illustrated in the cuts that it hardly needs any further description.



PADDOCK ARC LAMP HANGER.

The hanger affords safety from the falling of lamps, and all attendant dangers and expenses by reason of insecure fastening or the breaking of ropes. Combined with the hanger is a sleet-proof pulley, which is always indispensable in this sort of device. The hanger is being placed upon the market at an extremely low price.

THE WILLIAM POWELL CO.

THE new catalogue of the Union Brass Works of 50, 52, and 54 Plum street, Cincinnati, O., is one of the most complete, substantial, and business-like trade publications that has lately come under our notice. It contains 104 pages of well-printed and profusely illustrated matter, is strongly bound in cloth, and contains descriptions of all the improvements up to date of the lubricators, signal oilers, valves, etc., manufactured by this enterprising company. The catalogue ought to be in the hands of every electric light station superintendent.

CROCKER-WHEELER MOTOR CO.

THE Crocker-Wheeler Electric Motor Company are full of business. They have just furnished a ½ h. p. motor for the new Chilian cruiser being fitted out in England. Their orders on hand are very heavy.

NEW PULLEY CLUTCH AND CUT-OFF COUPLING.

THE accompanying engraving, Fig. 1, shows the new pulley-clutch designed by Mr. W. J. Woodcock, and now being built by the Allentown Foundry and Machine Co., of Allentown, Pa., and which embodies a number of ingenious and valuable features. The clutch is shown in transverse and longitudinal sections, respectively in Figs 2 and 3. As will be seen, the long hub I cast

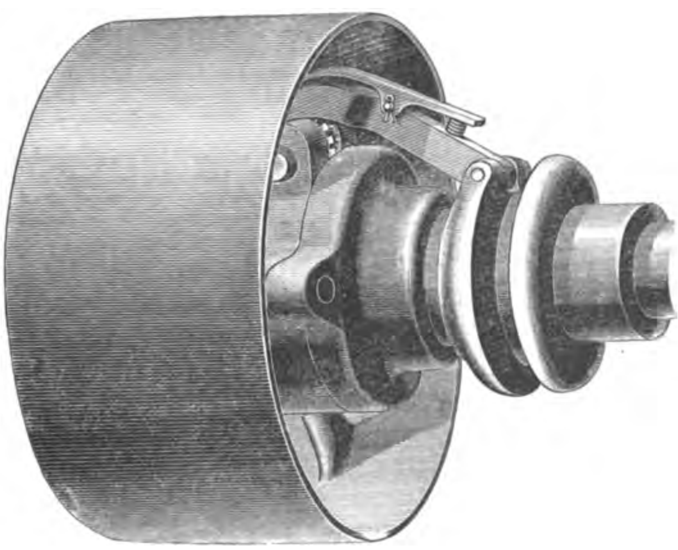
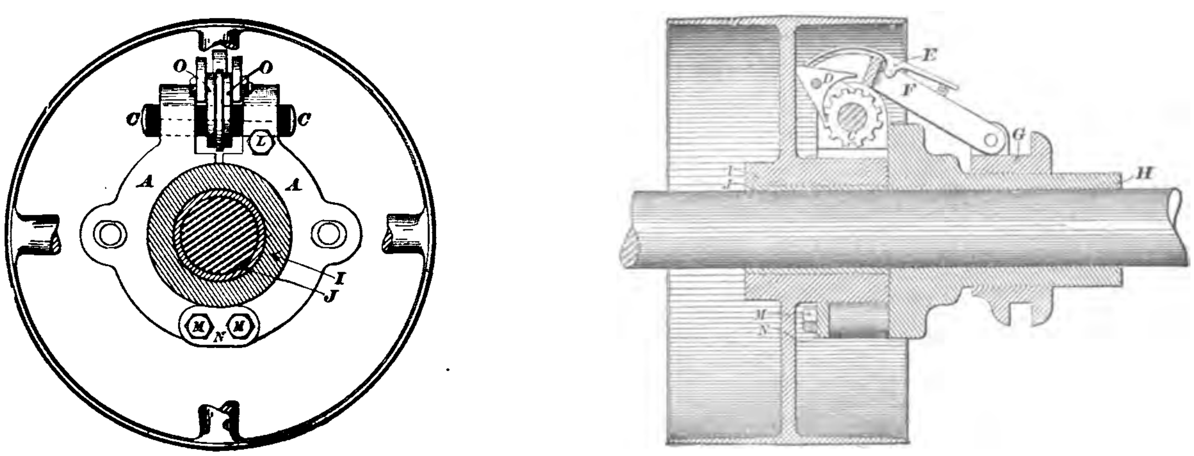


FIG. 1.—WOODCOCK PULLEY CLUTCH AND CUT-OFF COUPLING.

to the pulley is bored out and lined with a brass bushing, J. This pulley runs loosely on the shaft, and the long hub of the flanged coupling H is keyed on the shaft. The hub of this coupling is turned off to allow the sleeve G to move longitudinally on it. Each clamp is pivoted on a bolt, M; these bolts are fitted into the flange of the coupling H, so as to cause the clamps to revolve with the coupling. For further security a plate, N is placed under the heads of the bolts M M to tie the two together. The right and left-handed screw C C works in brass nuts, which are fitted in the clamps A A, and by turning this screw in one or the other direction the clamps A A are either tightened or loosened on the hub I of



FIGS. 2 AND 3.—WOODCOCK PULLEY CLUTCH AND CUT-OFF COUPLING.

the pulley. For the purpose of turning the screw C C in either direction a ratchet wheel is fastened to its centre, which engages with the pawl D; the pin on which this pawl works passes through two links, O O, which are free to rotate on the screw C C; this pin also passes through the forked end of the lever F. The other end of this lever is attached to the sleeve G, as shown.

From the foregoing it will be seen that the links O O form a connection between the screw C C, the ratchet wheel, pawl, and lever F. A finger E is fulcrumed on the back of the lever F, and the spring acting at one end, causes the other end of the finger to press on the pawl D, keeping the latter engaged with the wheel. Now, by means of a suitable fork and collar in the groove of the sleeve G a longitudinal movement can be given to the sleeve while the shaft is in motion. When the movement of G is towards the pulley, the lever F is carried forward, and the pawl and ratchet act to tighten the clamps A A, thereby transmitting motion to the pulley; when a loosening of the clamps is required the sleeve G is moved back sufficiently to reverse the pawl D; the finger E in this case will bear on the other side of the pawl, causing the ratchet wheel to loosen the screws.

By this simple means the position of the pawl is quickly changed, thereby producing an action either for tightening or loosening the screw C C, according to which side of the pawl is engaged with the ratchet wheel, the whole arrangement requiring but a small space on the shaft. A marked advantage is claimed for this clutch, namely, the tightening may be gradual, thereby starting the machinery slowly, and by further tightening, all slipping on the pulley is prevented. For dynamos, and other machinery requiring caution in starting, this clutch is said to be well adapted.

For cut-off couplings the pulley part is not required; one section of the shaft extends into the hub I sufficiently far to support it while running loose, and the hub I is keyed on the other section of the shaft.

At L a screw is provided when soft metal or a wooden plug is to be brought in contact with screw C. By tightening the screw L the plug is brought in contact with C, and makes it tighter in the thread, so as to stand without loosening when in use.

STANDARD ELECTRIC TIME CO.

THE above company, of New Haven, Conn., are to have quite an exhibit at the Montreal convention. They will furnish three large dials, 24 inch, on the main gallery, besides numerous smaller dials in the other departments of the building. These will be operated by one of their self-winding regulators at the headquarters in the exhibition building, where they will have an exhibit of their secondary dials, self-winding clocks, and electric gauges.

E. G. BERNARD & CO.

MR. E. G. BERNARD reports having closed contracts during the past week for four plants, one for a knitting mill in Cohoes; one for a woolen mill in Marcellus; one for a silk mill in Argusville, and one for a hotel in Albany. This makes Mr. Bernard's sixty-ninth knitting mill plant.

WIRE FOR THE MASONIC TEMPLE, CHICAGO.

THE new Masonic Temple building, at Chicago, requires one of the largest isolated plants in the country, and over 65 miles of Simplex wire will be used for the circuits. The competition was quite severe, but the merits of the Simplex Co.'s make counted, and George Cutter will supply all the wire used for the lighting circuits.

BISHOP GUTTA-PERCHA CO.

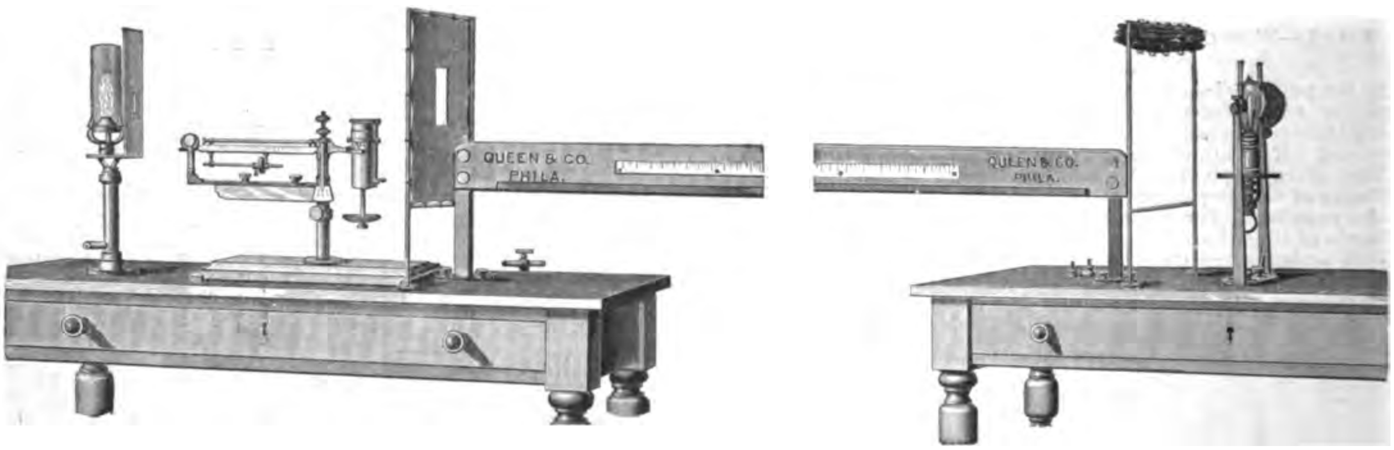
THE above company, of 420–426 East Twenty-fifth street, this city, report business as good and improving. This concern is not only one of the very oldest in its field, with a large number of early and interesting installations to point to, but it has been quite active in supplying wires and cables for all the later developments of electricity, including underground work in the great cities, submarine work in New York Harbor, and the transmission of alternating currents of high potential. The company's catalogues and sample cards will be found useful.

NEW LABORATORY PHOTOMETER.

MANY photometers are catalogued by instrument manufacturers and sold as suitable for electrical work, but these photometers are primarily gas photometers made to do duty as electric light photometers. Recognizing this fact and appreciating the demand for an instrument especially adapted to electrical measurements and provided with accessories to this end, Messrs. Queen & Co., of Philadelphia, last spring took up the problem and have brought out the photometer illustrated in the accompanying engravings. The instrument and accessories were designed by Mr. Elmer G. Willyoung, of Messrs. Queen & Co., and the first one built was recently sold to the Standard Lamp Co., of Appleton, Wis., where it is giving great satisfaction.

The photometer is of the usual Bunsen type. Two tables, each four feet long by 20 inches wide, support the graduated bar and accessory pieces. These tables are of white wood with ebonized top and can be firmly screwed to the floor; the table legs unscrew so that the whole apparatus can be packed in comparatively small compass for transportation or storage. The tables stand at such a height that observations may be taken by a man of medium height without bending. The bar is of metal supported by a larger bar of wood; the graduated bar is made in several different lengths and either graduated directly in candle-power or else, in the metric system, to half centimetres. The wooden bar is made with a cross-rail along the bottom, along which rides the carriage containing the Bunsen disc or "grease spot"; this carriage is arranged so as to rotate through 180 degrees about a vertical axis, thus allowing measurements to be made with each eye alternately toward each light and, hence, taking the mean of observations, eliminating largely the errors due to differences of vision between the two eyes.

As a standard may be used a candle-balance, a Methven screen,



NEW QUEEN LABORATORY PHOTOMETER.

or an incandescent lamp, as may be preferred. The left-hand table is provided with cross-rails parallel with the width of the table. The candle-balance is mounted upon a base fitted to these rails, and when drawn forward to the limit of the rails is in correct position for use as a standard. Pushing the balance back out of the way, brass bed plates are disclosed, upon which the Methven screen or standard incandescent lamp (held by a special socket) may be placed and firmly fixed by means of two milled-head screws. The right-hand table is also provided with bed plates in such a way that the universal socket, the Methven, or the standard incandescent lamp may be placed in position and their light measured by comparison with any of the other standards; hence the checking of the standards among themselves or the standardizing of the standard incandescent lamp can be very easily and quickly done.

The candle-balance has been arranged for weighing candles while burning. The bar of the balance is graduated in half-grain divisions and differences of weight can be read off by means of the rider up to 50 grains. Equilibrium is secured by means of a counterpoise weight sliding along a rod beneath the balance beam; the rod itself is threaded at one end so as to be used as a micrometer adjustment when the counterpoise weight is fastened by means of the check-screw. Either one or two candles may be used as desired. The balance also has an adjustment in its own length for bringing the line passing through the centres of the candle flames exactly at the zero of the scale.

For holding the incandescent lamp to be measured, the universal socket shown on the right-hand table has been devised. By means of this socket any lamp of any make may be presented to the sight box at any angle whatsoever. This socket consists, essentially, of a lamp socket with its central axis perpendicular to a graduated circle. This socket can be rotated about this vertical axis and clamped in any position; the amount of rotation is measured by means of an index attached to the socket. A small set-screw allows the index to be set at zero when the plane of the carbon filament is at right angles to the table length. The socket as a whole can also be rotated about a horizontal axis cutting the line passing through the center of sight box and center of illumination of the standard; the amount of rotation is read here also by means of an index and graduated circle. In order to bring the axis of greatest illumination of the lamp into the axis passing through the centre of the sight box, the frame supporting the socket proper may be raised or lowered to whatever point desirable and there fastened. With the universal socket, as with the candle-balance, there is a small adjustment in the length of the table, thus allowing the axis of greatest illumination to be placed exactly at the end of the scale. Both circles are graduated to every five degrees.

The standard incandescent socket, not shown in the engravings, is designed to hold an incandescent lamp to be used as a standard; as stated before, this lamp socket may be placed upon the right-hand table and its candle-power measured by comparison with either the candle-balance or the Methven screen; it may then be placed upon the left-hand table and used as a standard, thus making both the standard and lights measured of the same color, and hence greatly facilitating observations.

Curtains are provided for excluding extraneous light. All metal parts are finished dead black.

It is intended, as time permits, to adapt to this photometer several different accessories for use in taking measurements according to different methods, as, for example, Prof. Nichols' spectro-photometric method, the method of Lommer and Prudhun, recently described, etc. It is contemplated also to adapt the photometer to arc light measurements by adding certain accessory pieces.

THOMPSON & ROBERTSON.

THE above firm, of 258 Broadway, have notified the trade that they have secured the sole right to manufacture and sell the celebrated "Fibrous" dry battery and Fibrous Disc Leclanché porous cup, heretofore made by Taylor & Walsh, of this city. These will be manufactured under the personal supervision of the inventor and well-known electrician, Mr. J. Hart Robertson, and Mr. Louis Walsh, the latter of whom, it may be added, will represent the firm at the Montreal Convention. These Fibrous batteries are said to be superior in their durability, constancy, and great recuperative powers, and are specially recommended for all classes of open circuit work.

ELECTRICAL SUPPLY CO., CHICAGO.

CATALOGUE No. 44, just issued by the above concern, of 104 Michigan avenue, Chicago, is devoted to electrical house goods, and includes telegraph, fire-alarm, district messenger systems, and school supplies. It is a very handsome and complete publication, and gives all the needed information in regard to a very large variety of apparatus of the classes named. The catalogue, moreover, is not less ornamental than it is useful.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

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A CENTRAL STATION COMBINING THE ADVANTAGES OF BOTH THE CONTINUOUS AND ALTERNATING CURRENT SYSTEMS.[1]

BY H. WARD LEONARD.

WE are all well aware of the fact that the greatest strength of the three-wire system is due to features, the lack of which constitutes the greatest weakness of the alternating system, and that the reverse of this statement is equally true.

The high efficiency, reliability, safety and adaptability to supply almost any requirements for electric energy, which are the features of strength of the three-wire system, are the very points upon which the alternating system suffers by comparison, for its efficiency is much lower, its reliability is less, due to the fact that its machines are not practically operated in multiple arc, its safety is necessarily less, due to the existence of the high primary pressure, and its current is not adaptable to commercial use for motors, charging storage batteries, electro deposition, and so forth.

On the other hand, the low first cost of an alternating system, the simplicity of its circuits and of the operation of the central station, and its ability to reach with moderate expenditure of capital, lighting at any practical distance, make it the only possible pioneer in new and untried territory, without great risk, and almost the certainty, of expending capital which will never be remunerative.

Hence, it is that we find the three-wire system in possession of the densely settled centres of cities and towns, and not extending to the outskirts because of the uncertainty of a sufficient return upon the necessary capital, and both the central station manager and the distant would-be consumers anxiously awaiting the development of improvements which will enable the three-wire central station to supply such distant consumers. And hence it is, that the manager and consumers of an alternating system anxiously await the day when motors can be operated, and a more economical, safe and reliable current than the present alternating current can be furnished, by such a station to supply the imperative wants of the heart of a busy city.

If the above statement of the present existing conditions be a fair one, it will be evident that if we could only in some way secure the advantages of both systems in a common distribution, we should greatly improve matters. The object of this paper is to point out what appears to the writer to be a step forward in that direction.

The following conditions seem to be necessary:

1. We must supply a continuous current for the central portion of a town during the daytime when power is required.
2. We must supply the outlying districts with an alternating current during the night-time when lighting is required.
3. We must not operate the alternating system under conditions of light load when its efficiency is very low.
4. We must be able to supply current for lighting continuously throughout the 24 hours of the day.
5. We must have but one set of conductors in any consumer's place.

In order to meet the above conditions I propose the following:

1. Wire all consumers upon the standard three-wire systems.
2. Connect all consumers upon standard three-wire mains.
3. Arrange the network of mains so that the central section of the network can be disconnected from the outlying sections through the agency of switches.
4. Install three-wire feeders to supply the central portion of the systems at full load, and install 1,000-volt primary wires and alternating current converters with a three-wire secondary circuit to supply the outlying section at full load.

Let us see how we will operate the station. Suppose it is eight o'clock in the evening. The switches which serve to connect the central and outlying sections are open, and our three-wire plant is supplying the full load of the central portion of the city. The alternating plant in the same central station is supplying the converters of the outlying section, which convert from 1,000 volts primary to 220 volts in the secondary, and the secondary coil has a connection at the center which is led off to supply the central wire of the three-wire system of the outlying section, the outside terminals of the secondary being connected to the outside wires of the three-wire system. It will be noticed that both plants are being operated at full load.

Now, suppose it to be eleven o'clock. The load has gone off rapidly so that the alternating plant is now operating under the worst possible conditions, and these conditions will continue for the outlying district until dusk the next day—that is, for probably 18 hours. An operator is now sent out who goes to each section supplied by a converter, and, by throwing a switch, transfers the secondary wiring from the alternating system to the three-wire mains. In this way the small remaining load is gradually transferred to the three-wire plant, and then the alternating plant is shut down. The three-wire plant continues in operation all night and all the next day, supplying all devices with a continuous current. Motors can be operated in all portions of the system, even for domestic purposes in the distant residences, and all consumers get the opportunity of the use of the continuous current for any purpose desired for 18 hours out of the 24.

Dusk now arrives and soon the heavy lighting load will rapidly come on, and in such case the outlying section could not be supplied by the small wires feeding the distant three-wire section during the day, which are only about one-tenth the size which would be necessary to supply the full load.

The operator again goes round the circuit, and now transfers the load of the outlying section from the three-wire plant to the alternating plant, and this condition prevails again until eleven o'clock arrives, when the operation is repeated, as before described.

The switches for transferring the load of the outlying section from one system to the other, can readily be controlled by simple means from the central station itself, if desired.

Now, let us look at some of the advantages we have gained.

All of our inside wiring is done on the three-wire systems for use of a lamp of 110 volts. This means that for the same distances and loss in conductors we will save eleven-twelfths of the cost of copper which would be required by a secondary using 55-volt lamps upon a two-wire system; or, to put it another way, we can supply 110-volt lamps upon a three-wire system with the same cost of copper and the same percentage of loss in conductors at three and a half times the distance which would be permissible for 55-volt lamps on a two-wire circuit.

We all know the great desirability of using large converters, on account of their cheaper first cost per lamp and their higher efficiency, and also because a far more perfect regulation of pressure can be obtained upon a lot of lamps scattered in different kinds of stores throughout a block, if they be supplied from one converter, than can ever be obtained by supplying these lamps by a lot of small converters loaded differently in almost every case, and consequently supplying a different pressure at the secondary terminals of each converter.

Under the system proposed by me one converter would ordinarily supply the entire lighting of a block, resulting in less first cost, higher efficiency of conversion, longer life of lamps, greater reliability and greater simplicity of plant.

A point worthy of notice is that for 18 hours out of the 24 an absolutely safe pressure is in use throughout the entire system, and that during all day-light hours, when the greatest liability to accident from contact with high pressure wire exists, no high pressure is in use.

With such a system no consumer need be turned away.

The consumer who wants to charge storage batteries, and also make electric welds by electricity, can do so upon the same day and from the same wires that supply his incandescent lamps.

The factory upon the outskirts of a town, which runs its isolated plant, and must to-day either use storage batteries or run machinery all night to supply a few watchman's lights, can now switch on to the central station at six o'clock, and operate the few lamps it may need until dusk next day, when heretofore the alternating system, which was the only one which could reach it, did not run after midnight, or possibly after daybreak, because of the loss of money in so doing.

1.—Read before the National Electric Light Association, Montreal, P. Q.

With this system the outlying districts can be pioneered with the least first cost and least risk. Any outlying section in which, from any cause, the demand increases greatly beyond that originally anticipated, can be supplied permanently by the three-wire system by merely running the necessary feeders to supply the already existing mains, and in such case the switches and converters would be moved out further, or transferred to some new section ready for pioneer work.

The combination of a storage battery system and an alternating system also presents peculiar advantages. The storage battery is at its best when supplying a small steady load, such as we have for at least 16 hours out of the 24. The alternating is at its best when supplying the full load possible only during the remaining eight hours. The average electrical load on a general system is only about 12 per cent. of the maximum, consequently we are entirely safe in the statement that the greatest load during the 16 hours of light load is not more than 10 per cent. of the maximum load for the 24 hours.

If we are to attempt to operate the heavy load by storage batteries, we must either make an enormous investment, or, what is even worse, operate storage batteries at a disastrous overload. On the other hand, if we try to operate the 16 hours' light load with converters, our efficiency, when operating at 10 per cent. of our converter capacity, would be unmentionably low. But reverse the case and everything works at its maximum efficiency. During the eight hours of possible heavy load, we operate all devices by the alternating system. At the same time a continuous current dynamo charges our storage batteries located either in the central station, or, if more desirable, at different centres in the system of distribution. At the end of the eight hours' run we shut down the plant, lock up the station, and leave it for 16 hours, the storage batteries meantime supplying all devices.

If, for extraordinary reasons, we have not capacity sufficient in the storage batteries to supply the demand, we run the continuous current plant to assist it; and if that should fail or prove insufficient, we start up our alternating, and supply all, or a disconnected part, of the system with it.

With this plant distances are of no consequence; we can use 1,000 volts for the continuous current plant as well as for the alternating, and the single two-wire distribution is all that is necessary for perfect results.

The weak spot of this latter arrangement will, no doubt, be thought to be the storage battery, but my experience with this device is that if you use it properly under suitable conditions, and do not attempt to squeeze impossible results out of it, economical and satisfactory service can be obtained from it, and certainly no better conditions could be obtained for it than those described above.

Up to this time a bitter fight has waged between those believing that the alternating, the direct, or the storage battery, system, respectively, was the only suitable one.

I believe in them all, each operated so as to be used under the best conditions for its use, and I trust that the suggestions given above may lead to our being better able to meet and overcome our common enemies: High First Cost, Low Efficiency, Danger, Unreliability and the Inflexible Conditions of the existing demand.

CENTRAL STATIONS OPERATED BY WATER POWER.[1]

BY GEO. A. REDMAN, SUPERINTENDENT BRUSH ELECTRIC LIGHT COMPANY, ROCHESTER, N. Y.

THE purpose of my paper is more to give a description of what is being done with water for electrical purposes in the city of Rochester by the three different electric light companies doing business in that city, and some of my own experience with water power, than to take up your valuable time with the technical description of turbines, which can be gleaned from any of the numerous catalogues of turbine manufacturers, which contain full descriptions of turbines and their construction.

The adaptation of water power to electrical purposes has grown very rapidly within the past few years; there are several causes operating to enhance the value of water power, none more so than that of electricity.

Streams that have had no pecuniary value heretofore are now being utilized for the purpose of running electrical machinery, yet, at the same time, the supply of water is diminishing, caused by the destruction of forests, and water right owners in various parts of the country are devising means of storing water during the rainy seasons to furnish a supply during the dry season; also storing it in the daytime for night use. One large water right owner in Western New York, during the month of July and August, places flash boards two and one-half feet high on top of his dam, at an expense of $100, and stores up for night use the water which is not necessary for him to use in the daytime, thereby saving in the two months equivalent to a coal bill of $2,100.

1.—Read before the National Electric Light Association, Montreal, P. Q., Sept. 10, 1891.

The Johnstown, N. Y., Electric Light Company have improved their water power at the Cuyadota Falls by erecting a dam 34 feet high on top of the falls, giving them a total head of 75 feet and nearly doubling the amount of power.

A survey of the upper Genesee River, between Mount Morris, N. Y., and the celebrated Portage Falls, has been made during the past year for the purpose of establishing a reservoir that will furnish the city of Rochester 30,000 horse-power more, daily, during the entire year than they have at present.

The earliest forms of water wheels were the paddle and flutter wheels that only utilized the impulsive action of the water; these were followed by simpler wheels of the reaction type and others.

We now have the improved forms of the Leffel, Victor, Lesner, Success, and many others. There is a demand for the best and most economical turbine that can be manufactured.

Turbines should be built to secure the delivery of the water upon the turbine without checking the velocity of the water more than one-third, and permit the free discharge of same after passing through the turbine, and to work with as good efficiency under part gate as under full gate, and to be made of the best phosphor bronze, to stand the wear and tear under high heads.

It is essential to locate central stations to be run by water power, where there is no great danger of a flood, or so protected by a breakwater as to make it perfectly safe, and also to avoid trouble with back water upon the turbines.

Where a station is situated on the bank of a river, it is best to take the water from the river by means of a raceway, with the headgate parallel with the flow of the water, and at times of a freshet or running of anchor ice, it will more than pay any expense incurred by so doing.

The raceway should be of a sufficient depth and width to permit the water to flow not more than 90 feet per minute, and a waste gate should be placed in the side or end of the race to use in case of emergency; and when cleaning out the raceway a rack should be built across the race to prevent driftwood and other rubbish from passing into the turbines.

For that purpose I would recommend a rack built of iron slats two inches wide, one-eighth of an inch thick, and placed five-eighths of an inch apart on seven-eighths inch iron rods, at an angle of 45 degrees. Particular attention should be given to keep the rack clear by raking. A trough or platform should be placed over, and immediately back of, the rack to rake the rubbish and anchor ice into, and so arranged that a current of water from the race will pass through the trough and carry off all the rubbish, etc. For any one who is using 100 h. p. or over, it will be a great saving in labor and pay well for the extra expense incurred. For winter service a boom should be placed in front of the headgate, and the current will carry off a large portion of the anchor ice and other floating objects.

The headgates should be built to work with a rack and pinion; also a roller should be placed back of each gate stem to facilitate the handling of the gate.

The gates should have a protection built over them to protect the gearing from the storm. In cold climates, where the gates are apt to be frozen in, salt is essential in freeing them from ice; all headgates and timbers should be of the best quality of oak, and should be well bolted, and not less than two gates to one raceway. The tail race should have not less than two to three feet of dead water when the wheels are not in motion.

Where the tail race runs under the station, cement floors should be laid to prevent moisture in the station; a floor of that material will soon pay for itself.

Vertical turbines should be placed so that the steps are covered with water at all times. In adapting turbines to very high heads, or to conform to location, it becomes necessary to set the turbines above tail water, and conduct the water away from the turbines, through a draft tube; the same depth of pit and area of discharge is required where a draft tube is used, as would be when the turbines are set at the bottom of the fall; the mouth of the draft tube should always be submerged about six inches in standing tail water. It is claimed that draft tubes can be used 30 feet in length. I do not think a draft tube more than 18 feet in length should be used on account of the difficulty in keeping the tube air tight, for, if the tube leaks, the vacuum is imperfect and there will be a great loss of power, and where steps are used they will be apt to be burned out.

When possible, I would advise horizontal turbines to be used, as they are more easily taken care of, and are often used without any steps. The burning out of steps is an expense and annoyance. One of the greatest advantages in the horizontal turbine is that the dynamo can be belted direct to the turbine shafting, and is in some cases coupled direct to the turbine, making a good percentage in economy in power, and avoiding the use of gearing, and I deem it advisable to put in a number of small turbines, instead of one large one; in case of a break down they are more easily repaired, and cause less delay to customers.

In the old station of the Brush Electric Light Company, of Rochester, the vertical turbines cause considerable annoyance in the burning out of steps and stripping of the gears; so much so that it became necessary to support the vertical shafting with water cushions. For wooden steps we have had the best success with lignum vitæ.

In my opinion, governors for the turbines are necessary, and will govern any slight variation of load under high head, but where one-third or more of the load is thown off or on suddenly, it is necessary to handle the gate by hand, as under the above circumstances the turbine is apt to slack down or run far above the normal speed, as the case may be; in the latter case causing the burning out of lamps and armatures. The governors should be placed as near the turbines as possible to save lost motion in the gate shafting and avoid the use of gearing as much as possible.

We have two governors in use in our office building under a low head of 16 feet, and they govern the turbines under all circumstances in quite a satisfactory manner.

The decided advantage of a water power station over one run by steam power is not only one of economy in the saving of the expense of coal, but the station and apparatus can be kept cleaner and cooler, thereby saving considerable in expense of repairs. It is also far more pleasant for the employees.

The Brush Electric Light Company, of Rochester, purchased the entire lower falls of the Genesee River (which is about two miles from the business centre of the city) some nine years ago. At that time it was looked upon by many as a piece of folly, to think of running dynamos there, on account of the distance from the business centre of the city and the dampness around the falls. Notwithstanding the adverse opinions, they erected two buildings on the west side of the river above and near the brink of the falls, and put in two 30½ inch Leffel, two 20 inch Victors and one 40 inch Leffel turbine, the first four mentioned turbines, under 94 feet head, and the last under 28 feet head, with a total of 2,500 h. p. After running this power for five years they built a new station and leased their old power to different parties for pulp and flour mill purposes.

The new station is a three-story stone building, 45 feet wide and 90 feet long, with a two-story brick addition 42 feet wide and 80 feet long, and located at the foot of the falls on the east side of the river. The turbine capacity consists of 15 double 15 inch horizontal Lesner turbines under 90 feet head, with 14 foot draft tubes, a total of 3,360 h. p., using 6.95 cubic feet of water per minute per horse-power. But one turbine has been damaged to any extent in four years. The turbine casings are placed on iron girders with the ends of the girders resting on solid rock.

The amount of floor space occupied by all of the turbines is 4 feet by 38 feet; the weight of each turbine is 196 pounds, less than one pound to a horse-power; each turbine is placed in a separate division of the casings and the shaftings extend through the shafting room, upon iron bridgetrees, with 7 feet and 6 inches between journals, and the dynamos are belted direct to the turbine shafting; the shafting runs at 800 revolutions per minute, with 25 inch pulleys on the turbine shafting and 24 inch on the dynamos; we use untried beef tallow for lubricating, and are well satisfied with its results. The turbine gate shafts and governors are placed in the dynamo room at an average distance of 14 feet from the turbines, where they are easily handled by the attendants. We have in use four different styles of governors: the Walsh, Snow, Pritchard—electric, and one friction. With the latter we have done some experimenting. A tell-tale is placed in the shafting room, connected to a float in the race above the falls, which shows the height of water in the race at all times.

The water is taken into the raceway, about 80 feet above the falls; the race is 32 feet wide, and five feet six inches deep, and cut through the solid rock; there are four headgates with a house built over them; a wooden diagonal rack is placed in the race near the spillway to assist in freeing the race from anchor ice; the spillway is six inches deep and 32 feet long. The waste gates are placed next to the spillway, and are three feet six inches wide; there are two of them. In front and near the top of the penstocks an iron rack is built according to dimensions given; also a rubbish trough.

There are three iron penstocks, six feet in diameter and 80 feet high, built of three-eighths inch boiler iron, with a gate to each penstock.

There are five elbows to each penstock leading to as many turbines, with an iron slide gate to each elbow; in addition, each turbine has a register gate, thereby permitting the repairing of any one turbine without interfering with the running of the others. A turbine can be taken out and another put in its place in 25 minutes.

Cement floors are laid in the shafting and turbine rooms.

There are three tail races, extending under the entire length of the main building; each race is nine feet wide and six feet and six inches deep.

As a reserve power, when making repairs and cleaning the raceway, we have a 600 h. p. Cooper-Corliss engine; in the past year it has been necessary to use it but a few days.

For fire protection, two-inch iron pipes are run from the penstocks through both buildings, with four lines of hose attached at all times; the hose is tested once a week. In addition to the hose, a dozen fire pails filled with water and placed in different parts of the station are kept in readiness, and are not permitted to be used for any other purpose.

A record is kept of the time of starting and stopping of each turbine, also the speed and load on same, and any variation in height of water, and all repairs that are made. In addition to the above records, the day and night wheelmen report the condition of the power at the time they are relieved.

There are nine men employed at the station, five of them in the dynamo department and four in the water power department.

We have in service 30 dynamos; three of them are run without any stoppage, and the balance of them on an average of 13 hours per diem.

A record book is kept in the dynamo room, in which entries are made of the time of starting, stopping, speed and load of each dynamo, also all repairs of every description, all accidents to either machinery or circuits, nature, time and cause of same.

All the circuits are tested five times daily, and the tests and time of same entered in record book.

By means of the water power the company is enabled to furnish cheap and satisfactory light and power at the following rates, viz:

City arc lights, all night and every night, 27 cents per night; commercial arc lights, all night and every night, 40 cents per night; commercial arc lights, evening, 25 cents per night; commercial arc lights, evening and all day, 40 cents; ⅛ horse-power motor, $18 per annum; ½ horse-power motor, $48 per annum; 1 horse-power motor current, $72 per annum; 2, 4 and 6 horse-power motor current, $50 per annum, per horse-power; 8, 10 and 15 horse-power motor current, $40 per annum, per horse-power; ⅛ horse-power fan motors, $15 per season, from June 1st to Oct. 1st; 16 candle-power incandescent lamps, $5 to $12 per annum; 25 candle-power Bernstein lamps, $12 per annum; 50 candle-power Bernstein lamps, $24 per annum; 100 candle-power Bernstein lamps, $48 per annum.

The rates I have mentioned are for arc circuits; our rates for current on 500 volt constant potential circuits are as follows, viz:

One horse-power, $48 per annum; 2 horse-power, $96 per annum; 5 horse-power, $180 per annum; 8 horse-power, $240 per annum; 10 horse-power, $300 per annum; 15 horse-power, $450 per annum; 20 horse-power, $600 per annum.

We operate a total of 832 motors, of which 196 are fan motors, 1,896 arc, 135 Bernstein and 200 Swan incandescent lamps. One motor circuit contains 26 miles of outside wire and one 2 horse-power and one 4 horse-power Brush and 394 ⅛ horse-power "C & C.," motors, and is run with a No. 8 Brush arc dynamo. We have one 40 K. W. 500 volt "C. & C." generator in service on an eight mile circuit, with 48 horse-power in motors in use; the ammeter averages 29 amperes. We experience no difficulty in running same with our power.

The 26 mile motor circuit is the most popular circuit we have, and is run through the north-east suburban portion of the city. All the motors on this circuit, with a few exceptions, are placed in tailor shops that are either in the dwellings or in shops built in the rear of the dwellings.

The rebate for poor service during the year ending December 31, 1890, was one one-hundreth of one per cent. of the gross receipts, and the uncollected accounts for the same period was one tenth of one per cent. of the gross receipts.

The Edison Electric Light Company have recently erected a three-story stone station at the foot of the upper Genesee Falls, on the west side of the river, and have at present two double discharge Leffel mining wheels under about 90 feet head, giving 600 h. p., and are placing two more of 400 h. p. each. In addition, they have a fine steam station in the centre of the business district. Incandescent 16 candle-power lamps are furnished at one cent per lamp hour; arc lamps for city use, 28½ cents per night; municipal incandescents at six cents per night. The latter they are partially replacing with arc lamps. They have in circuit 105 arc, 805 municipal and about 13,500 16 candle-power incandescent lamps.

The Rochester Electric Light Company's plant is situated at the upper Genesee Falls, on the east side of the Genesee River, near the business centre of the city.

The station is three stories in height from the top of the falls, with the wheel pit underneath, blasted out of solid rock 95 feet in depth. They have five Leffel horizontal turbines; four are 23 inches, and the other 30½ inches in diameter, with a total of 1,500 h. p., under a head of 86 feet 8 inches.

The penstock is a steel pipe seven feet in diameter; the power is transmitted to five shafts, 80 feet above, by belts 173 feet in length, running at a speed of 7,200 feet per minute.

The dynamo room is directly over the shafting, from which all of the dynamos are belted through the floor. The dynamos are those of the United States system.

They have in service 325 city arc, and 140 commercial arc, lamps; also 1,500 incandescent lamps and two 10 h. p. motors. They have just placed one 85 h. p. generator and one 1,500 light Westinghouse alternating dynamo.

As a reserve power, they are putting in a 400 h. p. engine. The city lights are being furnished at 27 cents per light.

In addition to those I have mentioned, there are five incandescent plants and one arc isolated plant run by water power in Rochester, some 500 incandescent, and 25 arc, lamps, making a grand total of 1,991 arc, and 16,640 incandescent. The population of Rochester is 135,000, making a very high average per capita.

UNIFORMITY IN METHODS OF KEEPING CENTRAL STATION ACCOUNTS.[1]

BY J. J. BURLEIGH, CAMDEN LIGHTING AND HEATING CO.

THE National Electric Light Association partially fills its mission by bringing together, twice a year, central station managers and others interested in the production of light and power, but notwithstanding the very valuable paper of Mr. A. R. Foote, read at the Niagara Falls meeting, and the papers of Messrs. Smith and De Camp, read at the Kansas City meeting, absolutely nothing has been accomplished towards a uniform system of accounts or a classification of expenses.

All, I am sure, feel the very great necessity for a more comprehensive and uniform system of accounts.

A system that will show the exact cost per unit of their output.

A system that, being kept uniformly by all, will give managers an opportunity of comparison with each other.

This knowledge of cost per unit of output is particularly felt at this time, since nearly all central stations are in direct and active competition with other illuminating companies and with other means of supplying power.

At present no two keep their accounts alike; hence, comparison with each other is out of the question.

The principal function of accounting is to bring out the fact that the average cost of certain items of expense per unit of output in one station exceeds the average cost per unit of the same items of expense in another station, and the accuracy of these averages depends entirely on the uniformity of accounting. Great differences in these averages would prompt an inquiry as to the cause, and if the circumstances did not warrant higher averages, steps could be taken to reduce the cost of these particular items.

To make these comparisons of any value to those desiring to make use of them, a uniform classification of accounts should be adopted, and, to insure accuracy, the different items of expense, chargeable to the different accounts, should be specified.

The operating accounts proper embrace the current working expenses and the cost of keeping in good order the original plant.

The company with which I am connected have classified their accounts as follows:

CHARGEABLE TO	Arc Lighting.	Incandescent Lighting.	POWER.		TOTAL.
			St. Cars	Stationary	
Boilers, repairs of					
Belting, "					
Boiler House and Stack, repairs of					
Carbons					
Clerks					
Converters, repairs of					
Dynamos "					
Dynamo Attendants					
Enginemen and Firemen					
Engines, repairs of					
Fuel					
General Officers' Salaries					
Horses, Wagons and Harness					
Insurance					
Int. on Notes, Bonds and Mortgages					
Incidentals					
Instruments of all kinds					
Lamps, repairs of					
Lamp Supports and Fixtures					
Lamp Globes					
Lamps, Incandescent					
Linemen					
Labor at Stations					
Labor on Street Cars					
Loss and Damage					
Legal Expenses					
Meters, repairs of					
Motors "					
Oil					
Office expenses, repairs and furnit. for					
Poles and Lines, main. and renewals of					
Right of way					
Station, repairs of					
Stationery and Printing					
Superintendent and Foremen					
Steam Piping, repairs of					
Shafting "					
Taxes, City					
Taxes, State					
Tools, repairs and renewals					
Trimmers and Inspectors					
Water					
Waste					

All expenses that are naturally or entirely charged to either arc lighting, incandescent lighting or power are entered in their respective columns; expenses that are not entirely charged to any one service are apportioned on horse-power output basis, making the division as between arc, incandescent or power, in the proportion which the horse-power used for each bears to the total horse-power output.

1.—Read before the National Electric Light Association, Montreal, P. Q., Sept. 10, 1891.

For the proper division of those accounts not chargeable entirely to any one of the principal departments; for example, the total output of the station being 1,000 h. p., the company operating 500 arc lights, 2,500 incandescent lights and 250 h. p. for power, the division of a bill for boiler repairs, engine repairs, fuel and similar divisible accounts, would be one-half arc lighting, one-quarter incandescent lighting, one-quarter power.

The division ought to be accurately determined each month.

No intelligent economy can be practised without a thorough knowledge of the cost in the past and a comparison of the same with the present outlay. Constant comparison of accounts tends to economy. The experience of other companies is a good guide and would be found of great utility.

I would like to urge upon the convention the importance of the adoption of some uniform classification of expenses that they can recommend to central station managers for their adoption.

It does not follow that central station managers are to expose their books in detail, but to so prepare their accounts that they can give the secretary of the National Association replies to such questions of cost per unit as would be proper to exhibit to the other members.

Such statistics would be of the greatest interest and value; indeed, it would be of more value than all the other papers combined.

I have a station producing arc and incandescent light and power, earning a moderate dividend for its shareholders, but I have nothing to guide me as to how my expenses per unit compare with other central stations. I would give much for such information.

Therefore, I conclude that this is one of the most important subjects that can engage the attention of the Association.

CAMDEN LIGHTING AND HEATING CO.

Statement of Expenses for..................189

HEADS OF ACCOUNTS.	Arc Lighting	Inc. Lighting.	POWER.		TOTAL.
			St. Cars	Stationary	
Boilers, repairs of					
Belting, "					
Boiler House and Stack, repairs of					
Carbons					
Converters, repairs of					
Clerks					
Dynamo, repairs of					
Dynamo Attendants					
Enginemen and Firemen					
Engine, repairs of					
Fuel					
General Officers' Salaries					
Horses, Wagons and Harness					
Insurance					
Int. on Notes, Bonds and Mortgages					
Incidentals					
Instruments of all kinds					
Lamps, repairs of					
Lamp Supports and Fixtures					
Lamp Globes					
Lamps, Incandescent					
Linemen					
Loss and Damage					
Labor at Station					
Labor on Street Cars					
Legal Expenses					
Meters, repairs of					
Motors "					
Oil					
Office Expenses, repairs and furniture					
Poles and Lines, repairs and renewals					
Right of Way					
Station, repairs of and furniture for					
Stationery and Printing					
Superintendent and Foremen					
Steam Piping					
Shafting					
Taxes, City					
Taxes, State					
Tools, repairs and renewals					
Trimmers and Inspectors					
Water					
Waste					
Total Expenses for Month					

Total average arc lights, ...
Total arc light hours, ...
Total cost per arc light hour, ...

Total inc. output in ampere hours, ...
Total as shown by meters, ...
Total loss, ...
Total cost per 100 ampere hours, ...

Total stationary power output in watt hours, ...
Total as shown by meters, ...
Total loss, ...
Total cost per 1,000 watt hours, ...

REMARKS.

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ELECTRIC RAILROAD CONSTRUCTION AND OPERATION AND A CONSIDERATION OF THEIR CONNECTION WITH CENTRAL STATION INTERESTS.[1]

BY C. J. FIELD, OF THE FIELD ENGINEERING CO., NEW YORK.

INTRODUCTION.

THE advantages of the electric railway have passed beyond the age of experiment or question. They are proved by their development in the past four years, and any argument as to their advantage in the general development of street railway practice or suburban rapid transit is antedated. It took several years to convince old staid financiers and directors of the larger street railway properties that it was to their financial advantage to throw in the scrap heap several million dollars, more or less, in equipment and spend that amount in addition and still make it pay; but they have seen this advantage in the development and increase of traffic and returns to their company. These returns have been brought about principally by the development of rapid transit, in the introduction of electricity and the flexibility of the system in adapting itself to all and any conditions of commercial practice.

In looking over the past four years of practice in electric railway work, we have much to commend and considerable to condemn. The boldness of the achievements, the problems that have been solved, the rapidity of development and the perfection of the apparatus, seem almost beyond comprehension. That this apparatus, in less than four years, should reach the high state of perfection, economy and efficiency that it has, as compared to the long years of development of other mechanical appliances, is remarkable. The natural consequence of this large amount of work and development in this short time is that there has been much work done that would have been better left undone, in the way of poor engineering, cheap work, and not a proper appreciation of the problem to be solved. These, in some few instances, have retarded the development and progress of electric railway work in their vicinity, but street railway companies have now come to a proper appreciation of the necessity of good work well done, and that the wisest and best method is to consider carefully what will bring the best return for the money invested—not necessarily on the blind basis of the highest cost being the cheapest, for money can be wasted in this way as well as in others. We have examples now in several directions of large equipments being installed on a sound engineering basis and with careful consideration of the best interests of the electrical fraternity, street railway owners and public combined, and we can safely add that there is no problem in this line which cannot to-day be taken up with a full assurance of practical solution and successful development in electric railway traction.

The future outlook of electricity in the development of rapid transit, inter-suburban, and even express service, is assured. We are coming now to the solving of the larger problems in this work and bringing the public to a proper appreciation of the resources and possible achievements in this line and its superiority over the old fogy systems of the past. We even see a considerable number of our friends from cable engineering lines of street railroad work coming over into the electrical fold, fully appreciating that the cable system has a very limited field for successful development and that electric traction is very broad gauge in the field of engineering work. Therefore, with this outlook, better construction work, better engineering, better mechanics, the solving of these larger problems is assured, and we see even to-day, in a number of cases, electric suburban traffic supplanting steam on a cheaper, better and more successful basis. The favorable report of the New York Rapid Transit Commissioners has done much to add to public confidence in this direction. Electric manufacturing companies are assisting the development of the work by making their apparatus more substantial, better in construction and more satisfactory in its mechanical design and operation. The reduction in the speed of the motors, the development of single reduction and even of direct connected motors, is doing much to add to the confidence in this line.

We hear asked sometimes, by laymen, the question: "What speed can electricity obtain in railway work?" The able consideration of this subject in several papers and practical experiments as well, enables us to reply very briefly but confidently to this inquiry, that speed and power in electric railway traction are only limited by road-bed construction; in other words, any speed is obtainable within the range of possibility, with the maintenance of proper track. We do not intend, however, to generally review electric railway work, but more particularly to give some details of the practical problems in their construction and operation, and, therefore, we will leave the consideration of other parts of the subject to papers which will, no doubt, treat it more fully.

STEAM PLANT.

The consideration of the best development in the power generation of electric railway work has been one that has received considerable attention in past years from the best engineers in this line. We reach here a part of the problem which requires much more careful consideration than has been given steam power in electric lighting generally in the past. The work to be successfully done by the steam engine in the generation of electricity for the operation of railroads is of the severest kind, and can be compared only to that of the engine operating rolling mill trains. It is owing to not fully appreciating this fact that we hear in some parts of the country of failures of steam plant on this kind of work. Electrical manufacturers are assisting the solution of this problem by the building of larger generators in units of 200 to 400 or 500 horse-power. What we want in the generating station for electricity is the smallest division of units consistent with the safe and economical operation of the station. Following the problem out on this line, we can build a successful station; and we would add to this that each unit should be entirely independent and separate from all other units, thereby increasing the reliability. This cannot be obtained in a safe and economical way by the use of our old friend, the countershaft. Undoubtedly, the countershaft has been of much use in electric lighting service, and particularly in arc lighting, but in railway work, with large generators, we can see no excuse at the present time for its use. Generators should be belted direct to the engines, whether Corliss or high speed, or else coupled direct to the engine shaft. With a Corliss engine of 500 horse-power, operating at 80 or 90 turns, with a fly-wheel 18 to 20 feet in diameter, we can belt with belt centres of, say, 40 feet, generators of several different commercial types; this gives us advantages which we have heretofore had only in high speed engines with direct connection. The engines should, in any event, as heretofore stated, be extra heavily built for the work to be done, with ample fly-wheel capacity. On engines of this size and speed a fly-wheel capacity of approximately 60,000 lbs. is about right. On engines operating about 150 turns, say, 30,000 to 40,000 lbs.

While laying particular stress on the rapid and sudden changes of load, we do not know how to illustrate it more forcibly than in Figs. 1 and 2. Fig. 1 will show a practical case of changes in the indicator diagram within one minute, placed on the cylinder of an engine running on railway work, which shows a variation within that time of from full load to no load and back again several times. Fig. 2 illustrates a load diagram from an ordinary case which has not been particularly selected for its maximum and severe conditions. These impress on the mind more forcibly than words can the requirements of this work. High speed engines in the development of railway work have received in some cases a set-back, owing to the engine manufacturers not appreciating fully the conditions and necessity of the work undertaken. So-called high speed automatic engines can be as successfully operated on this class of work as any other, if they are specially built for it. This means larger parts, bearings of more ample size and length and ample fly-wheel capacity. On a cross-compound engine of, say, 300 horse-power, there should be about six to eight tons in the fly-wheels, the bearings seven or eight inches in diameter and 15 or 18 inches in length. (Such a type of engine is being furnished by the manufacturers of the Ball Engine.) In the case of engines built in this manner, there can be no fault found with their operation. A type of engine, which we believe is going to be largely used on this class of work, as well as lighting work, is one that will come in between the high speed engine and the Corliss and which will combine many of the advantages of both. Such an engine has been sought for by many engineers and has been attempted by a number of builders. To-day, however, we cannot find it on the commercial market. This engine in units of 500 horse power would run at a rotative speed of about 140 or 150 revolutions and with a piston speed of about 650 to 700.

The question which has troubled most engine men in regard to the high speed engine, with a single valve covering this kind of practice, has been a question of valves and clearances. Beyond any question, when it comes to this size, we have got to come to the Corliss practice of double valve, thereby reducing the clearances and bringing it down to the extent of the Corliss practice. The writer's company is having built, for the electric railroad at Buffalo, two engines of this class, by the Lake Erie Engineering Works, which we believe will do much to develop this line of work, and, also, will be particularly adapted for coupling direct to the engine shaft. The trouble in this line has been to get electric manufacturing companies to take up the building of large multipolar generators adapted for direct coupling at a speed of from 100 to 200 revolutions. This problem was developed on a much smaller scale in this country, for marine plants, several years ago. We find that in Europe, where their work has been more special, they have successfully developed this type of engine and generator, and, beyond any question, it is going to be both for lighting work and for railway work the type of unit for central station practice in the future. It means, where the vertical engine is used, the installation of the steam and electric plant in the space formerly used for engines alone. This means reduction in the cost of building, operation and maintenance.

In concluding this part of our subject on steam generation, we trust that our experience in the past in lighting will show us the fallacy of poor steam engineering, and that we will build our sta-

1.—Read before the National Electric Light Association, Montreal, P. Q., Sept. 10, 1891.

tions for the future, and not have the problems before us that nine-tenths of the electric lighting stations have to-day, which mean, that in order to get down to commercial economy and competition, they have got to rebuild their whole outfit. We will merely append to the consideration of the steam plant part of our problem a few interesting figures and data which the writer collected for presenting to street railway companies, in order to give them some useful information in this respect. We believe that they may be well introduced here. The figures given on the tables, etc., are not ones that the manufacturer of an engine would tell you were those of the best economy for his engine or plant, but they are figures which will be appreciated by station owners and railway companies as those which are obtained in every-day commercial tests.

The relative commercial economy of engines and costs are as follows:

Type.	Lbs. of Coal per H. P. hour.	Cost per H. P. Sizes over 100 H. P.	
High speed single	4 to 5	$11 to $13	This is based on an evaporation of 9 lbs. of water per lb. of coal.
" " compound	3 to 3½	14 to 16	
" " " cond	2¼ to 2½		
" " " triple	1¾ to 2	18 to 22	
Corliss single	3½ to 4	16 to 18	
" compound condensing	1¾ to 2	22 to 25	
Corliss triple	1½ to 1¾	27 to 30	

Generator.	Engine.						
		High Speed.			Corliss.		
Watts.	Horse-Power.	Size.	Speed.	Wt. 2 Fly-Wheels.	Size.	Speed	Wt. 2 Fly-Wheels.
50,000	75	12 x 12	280	7,000 lbs.			
80,000	125	15 x 16	225	9,000 "			
150,000	225	18½ x 18	200	15,000 "	20 x 36	90	25,000 lbs.
2,150,000	450				24 x 48	80	50,000 "

Steam pressure, 100 lbs.

The cost of steam plant complete is about $50 to $60 per horse-power for high speed, and $65 to $75 per horse-power for Corliss.

ELECTRIC PLANT.

The question of the best electrical generating plant for railway work is one which is allied closely to that of steam plant, particularly in the relation of the generators to that of the engines. In some respects, in treating of the steam plant, we have intimated what our idea was in connection with the generators. All large generators of from 200 to 500 horse-power should be connected as directly as possible, either by direct belting or shaft coupling, with the engines operating the same. It is only by this development that the safest and best solution of electric railway station practice—in fact, station practice in general—can be reached. Manufacturers of railway generators have had an experience extending back many years, that experience in the development of direct current incandescent machinery; although not of quite the same voltage, has led the way up to the safe, economical and commercial development of railway generators; and we find the railway generator of to-day one of the most perfect and reliable factors in the electric railway system. The only problem remaining to be solved in this connection is to build them in larger types and have slower speed for direct shaft coupling. Generators on this work are subjected to the severest and most excessive strain, particularly where of small type, but the building of them in large units is going to remove, to a great extent, the question of the overloading of the machine. Railway machines are often

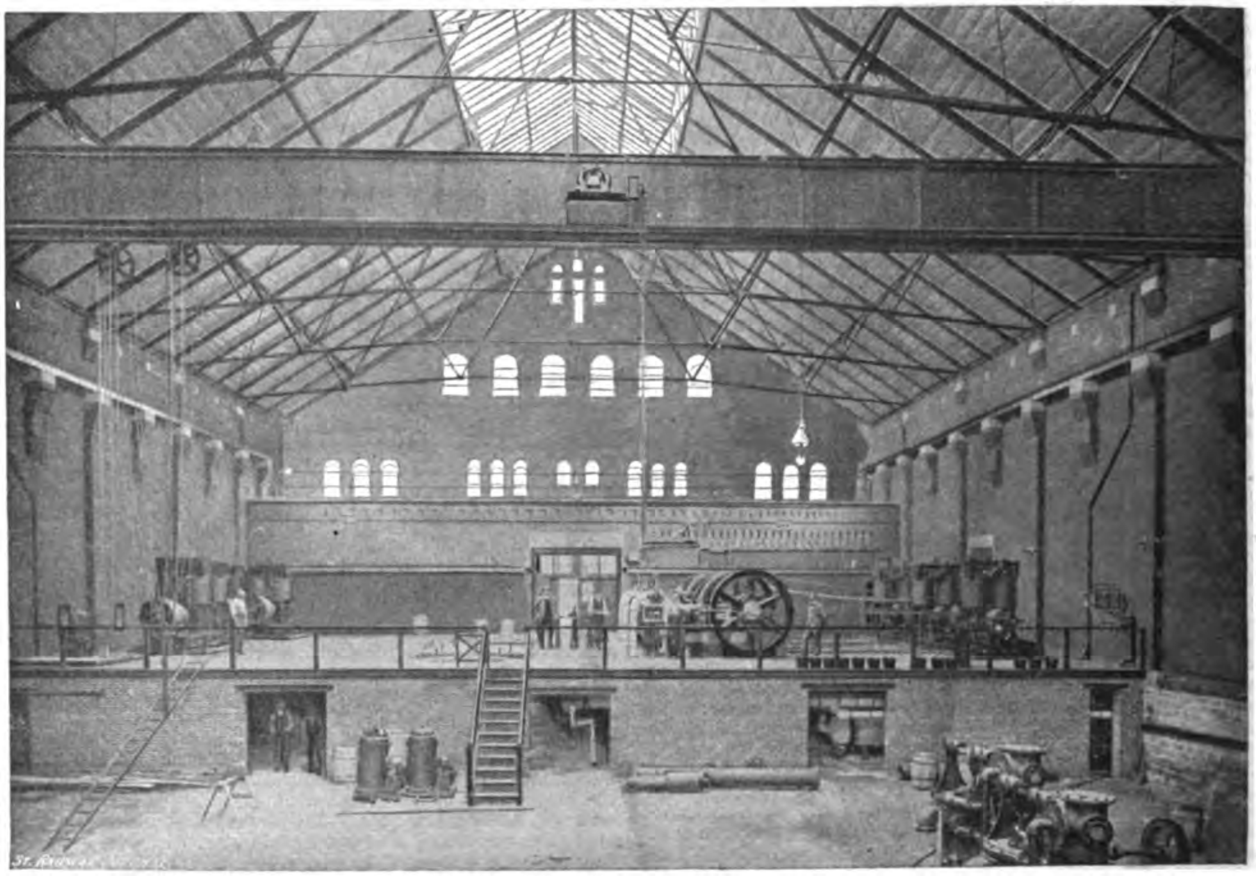

FIG. 4.—INTERIOR OF POWER STATION—BUFFALO RAILWAY.

There are four classes of boilers:

1. Horizontal return tubular, which is the most general in use, and costs $9 to $10 per horse-power.

2. Vertical tubular (Corliss or Manning), which is a vertical tubular boiler with water leg, giving an internal fire-box, economical in floor space, largely used throughout New England. Cost $10 to $12 per horse-power.

3. Sectional or water-tube boiler, of which Babcock & Wilcox is the best known, especially adapted for higher pressures and safety. Cost $17 to $19 per horse-power.

4. Scotch type of marine boiler—one that has not been used to any extent as yet in station work—but we believe it will be as an offset to the sectional type; and fulfilling the requirements for higher pressure and economy of space.

Capacity of engine requisite for different generators:

subjected to an overload of from 25 to 50 per cent. In general these are only momentary, and we find most of them able to stand up to the work to be done.

The question which puzzles many of the railway companies, as well as the electric companies, is, What amount of generating capacity is necessary for the operation of a given number of cars? This question, of course, has got to be carefully considered in connection with each case, but there can in a general way be laid down an approximate basis for this work. Some railway companies, in order to show a higher economy than their competitors, are unwisely claiming the requirement of a smaller amount of power than others; but the wisest manufacturer is the one who urges his client to install a larger amount of power than is barely required for the successful operation of the road under any and all conditions. For if any one thing will lead the public to condemn the electric railway traction it is a lack of power, thereby causing the cars to move slowly, and in case of any accident, disabling part of the power. A fair basis on general conditions for 16 to 18-foot car bodies is 20 to 25 h. p. per car, which, with a properly designed and constructed plant, will give the desired power. The cost of generating this power for railway work for 16 and 18-foot cars is three to five cents per car mile for all expenses of the generating station. In some roads we find that cars of a larger size than these do not necessarily take a proportionately larger amount of power. We find from practical experience that a car 32 or 33 feet long, double the size of the 16-foot car, takes under general conditions about 50 per cent. more power, and we find by the same experience that a trail car adds about 50 per cent. to the amount of work to be done on the motor car for the same size. As to the minimum and maximum amount of power taken on an electric car, we find that a general average for a 16-foot car, under ordinary commercial conditions, without excessive grades, is one horse-power per car mile per hour; or, a car operating at an average 10 miles per hour means an average of 10 horse-power per car. The same car will give, however, on a load diagram, taking all its conditions, from maximum to minimum, a variation of from nothing to 50, 60 or even 80 h. p. This gives us an idea of the severe strains and conditions to which an electric motor is subjected.

ELECTRIC CARS AND THEIR EQUIPMENT.

One of the questions on which we find more variety of opinion than any other is, What is the best size, type and style of car for given case and conditions. The old standard 16-foot car body we find is now being widely departed from, and the problem is, How large a car can we get on a single truck with four wheels without excessive destructive effect on the roadbed? and, What is the longest car we can operate on street car service economically on an eight wheel base? We believe the limit is reached with a single truck in a 20-foot car body; we know that the truck manufacturers claim in some cases to operate a longer body, but we do not believe it wise. An 18 or 20-foot car running under close headway we believe to fulfill best the conditions of city traffic in the larger cities. Such a car, with a wheel base of seven feet, and in some cases seven feet six inches, where curves are not too sharp, will give satisfaction, and not be too severe on the roadbed where the same is properly constructed. As to the difference in effect on the road-bed between the electric car and the horse car, it is, briefly, that the horse car is pulled by horses, from which it receives a balancing power and a steady pull, whereas an electric car is operating itself by a power moving the wheels against the track, having no steadying or balancing power from the pull of the horses, and transmitting all its power and moving itself through the wheels. We find, therefore, that it subjects the track to a very severe pounding, necessitating a much better construction of roadbed, practically equaling that of a steam railroad.

Some companies have favored the use of a vestibule on street cars. We believe, though, that any vestibule is a failure and a misnomer. It accomplishes no good and causes much trouble; a shield over the dashboard for the motor man in winter weather would give all that would be required. What is wanted on a street car is that which will allow the freest ingress and egress from the car for the passengers, and anything that retards this—and a vestibule most certainly does—is a detriment and an obstacle to rapid transit. On some roads we have tried the introduction of even larger cars, say, 28-foot body, or 36 feet over all. Such a car, of course, has to be put on a double truck. These cars have found favor with some companies when first considering the problem; the difficulty with them is in getting the passengers in and out of the cars as quickly as possible, and making too many stops, due to the larger number of passengers carried. For inter-suburban heavy traffic, with few stops, we believe such a car would fulfill the requirements, but only in such a case.

Thus, having gone over the question of the cars, we come to the consideration of the electric equipment for the same. To-day we find the double reduction motor discarded, as far as any new equipments are concerned. All the large electric manufacturing companies are placing single reduction motors on the market, and they are in successful commercial operation. One company is placing in the field a motor directly connected to the shaft and without any gearing—in other words, there is no reduction in speed, the speed of the armature being the same as that of the wheels—the same being accomplished by a very ingenious arrangement. We have heard asked in the past the question, Why was it necessary to place 30 h. p. to operate an electric car to do the work that two horses had done formerly? The answer is: The two horses did not do the work in a proper manner and give rapid transit. The life of a street car horse is very short, and we

FIG. 3.—CARS, POLES, AND OVERHEAD CONSTRUCTION—BUFFALO RAILWAY.

find under general conditions that 30 h. p. with two 15 h. p. motors has been found about right; in fact, we even find the companies tending towards a larger installation of power, particularly when using larger than a sixteen foot car body, and we find to-day, being installed for rapid transit in inter-suburban work, 40 and 50 horse-power electric equipments per car, many of them operating at a speed of 30, and even 40, miles per hour. As the amount of power is directly proportionate to the speed, we can readily see the requirement for such an amount of power. The cost of a single car equipped, including the car body, truck and motors, is from $3,000 to $3,500, and the cost of the electric part of the power generating plant is from $35 to $45 per horse-power.

LINE CONSTRUCTION.

We find in the past about as great a development in overhead and line construction for electric work as in any other part of the subject. While formerly this was one of the greatest sources of unreliability in the operation of the plant, to-day it has reached a very practical development. Formerly the trolley wires were too light, the feed wires were insufficient to furnish power, and the line was giving trouble, grounding and breaking continually. In the insulation of a single trolley system, with one side of the system grounded, we have the most severe requirements that it is possible to obtain in any electric insulation, in that any grounding on the other side of the system means trouble in the operation of the road. This has led to the introduction of double and even triple insulation into our line material to properly protect the trolley wire from grounding. Where streets are wide enough to spread the tracks to six feet and six feet six inches within the near rails we see introduced in many places centre iron poles, which make a considerably stronger style of construction than cross-suspension. There are not many streets, however, where street cars are in operation that are wide enough, or where the city will allow the spreading of the tracks to this distance, and in closer proximity it is not safe to operate with centre poles. On the work installed by the Field Engineering Co., in Buffalo, we find the most extensive system of overhead and underground construction in operation anywhere. Here all the feed wires, with a few exceptions, are placed in underground conduits, thus removing all cause for objection to the unsightliness of a large number of feed wires overhead. These underground feed wires are connected to the overhead wires from junction boxes upon the poles. Thus, in Fig. 3 is shown one of the lines on the Buffalo Railway system, which gives an idea of this style of construction, as well as the use of the large cars, which are 36 feet over all.

The cost of overhead construction may be summarized about as follows:

Line construction per mile, complete, including track bonding. plain pole work, cross suspension or bracket with feed wire	$2,000 to $2,500
With sawed and painted poles	2,500 to 3,000
Iron poles, cross suspension, concrete setting, double track, feed and guard wires	6,500 to 7,500
Same with centre poles	4,500 to 5,500

We also append a table which will give a general summary of the cost of electric equipment of street railway systems, omitting the track construction, which, of course, varies with the number of miles to be equipped.

COST OF ELECTRIC EQUIPMENTS FOR STREET RAILROADS.

No. of Cars.	Steam Plant. H. P.	Capacity of Generators, K. W.	Steam Plant.[1]	Station Electrical Equipment.	Car Equipments, Car Trucks and Motors.	Line Construction ½ mile of Double track per car.	Total Equipment (omitting track).
6	120	80	$7,000	$6,400	$19,500	$7,500	$40,400
10	225	150	11,000	10,500	32,500	12,500	66,500
15	375	240	17,500	15,000	48,750	80,000	111,250
20	450	300	22,000	17,500	65,000	40,000	144,500
30	675	450	28,000	22,000	97,500	90,000	237,500
50	1,125	750	50,000	33,000	162,500	187,500	433,000
100	2,025	1,350	90,000	60,000	325,000	375,000	850,000

The above figures are approximate only and based on the best City R. R. practice.

1. Add 25 per cent. to these figures for Corliss.

TRACK.

The track of street railway companies before the introduction of electricity was more behind the times than any other part of their equipment. The old flat rail is antiquated and antedated, and in a few years its use will be obsolete. The necessities of electric railway traction—in fact, of any traction—have impressed upon the street railway companies in their equipments the requirement of a good road-bed for the successful operation of a road, and we find this part of the problem receiving as much attention as any with companies who appreciate fully the work before them The general construction to-day is girder rails of from 60 to 80 lbs. per yard, placed on chairs where block paving is in use, with ties 2½ to 3 feet between centres. We find in some cases even 90 and 100 lb. rails used, but we believe in more moderate weight for the rails and the ties placed closer on centres. We believe this has been the general experience in railway work. Such a style of construction costs from $9,000 to $10,000 per mile. In suburban roads, on streets where there is no paving, we find the T rail being used; the road bed can be properly constructed on this basis with 45 to 50 lb. rail, for $6,000 to $6,500 per mile, the rail being spiked directly to the ties.

In order to make a summary of the data and figures, I will summarize them in a practical example.

AN ILLUSTRATIVE EXAMPLE.

I propose to take, as the best means of illustrating practically, the purchase, equipment and operation of a street railway system with electricity, a city with a population of, say 100,000—with a dilapidated street railway system, earning a gross income of $125,000, to purchase same for $500,000—property rights, franchises, etc., and equip it with 40 miles of single track and 65 electric cars.

COST OF EQUIPMENT.

Steam Plant (1,500 h.p. steam plant):		
Five engines, 250 h. p. each, compound condensing, size, 16 inches x 32 inches x 42 inches, with wheels weighing 30,000 lbs.	$32,500	
Eight R T. boilers, 72 inches x 16 feet	9,600	
Jet condensers	8,000	
Two boiler feed pumps	900	
Steam and exhaust piping	12,000	
Five engine foundations	8,500	
Eight boiler settings	3,200	
Five 30-inch belts	2,000	
Erecting and starting	3,500	
Freight and miscellaneous	2,500	
		$72,700
Electrical plant:		
Five generators, 200 kilowatts	$37,500	
Switchboard installation, foundations, etc.	4,000	
		41,500
Building:		
Power station, including stack, traveling crane, etc.	$25,000	
Car house and repair shop, including tools, etc.,	15,000	
		40,000
Track construction:		
40 miles girder rail construction, ties 2½ feet centres, 63 lb. rail, etc., $1.15 per foot	$244,880	
Relaying, including paving, etc., at 60 cents per foot	126,720	
Trucking, hauling, etc	24,000	
Ties, including 10 per cent. of joint ties, 130,000 at 40 cents	52,000	
Ties, including 10 per cent. of joint ties, 15,000 at 70 cents	10,500	
		456,100
Line construction:		
Ten miles iron poles, etc.	$75,000	
Ten miles wooden poles, etc.	40,000	
		115,000
Car equipment:		
65 electrical equipments at $2,000	$130,000	
65 car bodies, 18-foot body, with open ends	65,000	
65 trucks at $250	16,250	
		211,250

Summary:		
Steam plant	$72,700	
Electrical plant	41,500	
Building	40,000	
Track	456,100	
Line construction	115,000	
Car equipment	211,250	
		$936,550
Superintendent's and Engineers's work	$50,000	
General and miscellaneous	50,000	
		100,000
		$1,035,550
Original purchase		500,000
Total cost re-equipped		$1,535,550
Gross income, say, $350,000.		

Net income, say 35 per cent., equal to 8 per cent. on cost, on the basis of an investment of about one million and a half of dollars, and from a property which in many instances was hardly earning its fixed charges formerly.

We have here illustrated a practical example of what is being done every day in this country at the present time in the purchase

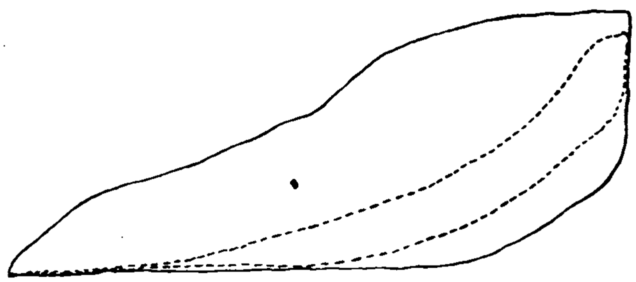

FIG. 1.

and equipment of street railway systems. In fact, we find a large number of bankers and capitalists giving it their earnest attention as one of the best fields for investment at the present time.

CENTRAL STATION IN CONNECTION WITH ELECTRIC RAILWAY WORK.

We desire to call the attention of central station owners to the profit to be made from the furnishing of power in street railway operation, and also by the combining in smaller towns of the street railray companies and electric light companies. The trouble in most cases in central stations obtaining contracts for power, outside of small roads, has been to convince the railway companies that the electric light station can economically and reliably furnish this power, and we must say, that in many cases their fears are well founded. Therefore, it behooves the central station companies to place their generating plants and station, not only for their own busiuess, but for this added business, in such a shape as to remove this objection. There is no reason why electric light stations should not do a large and profitable business in this line, as well as in stationary motor work, for the same factor is introduced here, and the same reasons hold, why they can safely and profitably furnish this power; if they have a station properly built, and large enough to add this power, that factor is established. If they have a proper station operating force, in many cases this force need not be added to at all. As to what basis this work can be profitably done on, we hesitate to state figures, except in specific cases, but will try to give a general idea of some of them. For many small roads power contracts have been taken at so much per day, assuming a basis of 100 to 125 miles operated. Such contracts have been at from $3 to $5 per car. The regular basis, in accordance with which most street railway companies make their contracts and desire to base their cost of operation, is the unit of car mile operated; therefore, most contracts are on this basis. This comes down, therefore, to a basis of from three to five cents per car mile; the latter figure we consider excessive, and one which would be only made by any company for temporary necessities. We know of cases where the matter has been carefully considered, and the plant properly installed for it, where contracts have been made for between 2¼ and 2¾ cents per car mile for 16-foot cars, on roads with grades not exceeding 1½ to 2 per cent. In this case, and, in fact, in most cases where the closer figures prevail, the railway company furnishes the generators, and the station owner furnishes the steam power and all expenses of both steam and electric power due to ordinary wear and tear. A profitable source of investment has been found in the more moderate sized towns of, say, up to 30,000 or 40,000 inhabitants, in the installation of combined electric railway and lighting stations; the companies either equipping new ones or purchasing old street railway systems and dilapidated lighting plants running on an unproductive basis, but which have a good franchise and field for business. Such companies have proved very profitable, as the combining of the operating expenses for railway and lighting station has done much to reduce expenses, and in many cases one manager or superintendent has proved sufficient for the entire system.

What we have tried to prepare here has been, not a paper which will be so attractive to merely read, but in which will be combined a certain amount of data and information which will be of use in the further consideration of the problems herein outlined, and trusting that, if we have accomplished nothing else, we have led you to a profitable line of thought, it is respectfully submitted.

FIG. 2.—DIAGRAM SHOWING FLUCTUATIONS IN LOAD.

ELECTRICAL STANDARDS.

At the last meeting of the British Association the report of the committee on electrical standards was read, in the absence of the secretary, Mr. R. T. Glazebrook, by Professor Carey Foster. The committee have made repeated measurements of the electrical resistance of several B. A. coils, and the result shows that the coils have remained practically constant since 1885. The report stated that notices have been sent out giving directions for setting up standard Clark cells, and asking that cells set up according to these directions should be sent to them. The object of this is to ascertain to what extent of accuracy different cells may be expected to agree with each other.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XII. NEW YORK, SEPTEMBER 16, 1891. No. 176.

It is doubtful if any great truth has ever been lost; though some may have apparently lain dormant for a time, yet they have continually produced results.—Joseph Henry.

CONVENTION ECHOES.

Of one thing we may be certain, namely, that none of the attendants at the Montreal Convention have any cause to regret spending a week in the beautiful Canadian city as recipients of a hospitality perfectly overwhelming in its heartiness and cordiality. When the Association determined to visit Montreal, it expected a repetition of such welcomes as it had enjoyed in Chicago, New York, Boston and elsewhere, but it never anticipated the fraternal greeting that awaited it in the commercial capital of the Dominion and that was to take so many forms of expression.

It might even be said that owing to the outflow of this hospitality, the social side was unduly prominent in the exercises of the week, but we at least cannot find fault with our host, who was willing to give us everything save Canada itself. One would like to make some return, but as every effort would be inadequate, it is allowable to hope that in the fixing of popular interest on electrical matters by this meeting and in the display of what electricity can do to promote the advance of Canada in prosperity and civilization, our friends in the Dominion will be rewarded.

In spite of the pressure of social functions on the time of the Convention, a great deal of good, solid work was done, and it was interesting to note that the attendance at the successive daily sessions was even above the average. The fact is, half the value of a Convention lies not in what is debated on the floor, but in what is chatted over in chance interviews and quiet corners by those who have notes to compare or are in search of special information. Many station managers are anxious to talk about their work with their fellows, or to ascertain private opinion as to the drift of things, but they are averse to making a parade of their desire for knowledge, and would much rather buttonhole a man on the subject than submit him to a very public *viva voce* examination.

Many of the utterances in the Convention were unusually significant, and their consequences may be very important. Take, for instance, the philippics of Mr. Weeks. If he has rightly voiced the sentiment of central station men as to the invasion of their territory from time to time, and as to the resolve to band against it, it is well to know that such a state of mind exists. The movement he has set on foot will need close watching, and it will undoubtedly have large sympathy so long as moderate measures are followed and so long as the result is to give permanence, stability and prosperity to electrical investment. The remarks also by Mr. Leonard and Mr. Huntley as to "composite" stations were most timely, and deepened the conviction as to the prospects of a very general development along that line of work. Seconding these were the eminently practical station papers of Messrs. Ayer and Burleigh; the discussion of Mr. T. C. Smith's paper of six months ago, and the debate on the new rules for wiring submitted by a special committee that had evidently been hard at work and had reached some very definite conclusions. It was fortunate also that two such admirable papers on electric railway work were offered by Capt. Griffin and Mr. Field. Central station men ought to be foremost in the promotion of electric railway enterprises, as one of the most profitable new fields into which they can carry their experience without making any sacrifice of existing opportunities in light and power.

Of the Exhibition it will suffice to say that it was the best commercial display ever given, and that in many respects it compared favorably with the International Exhibition at Philadelphia in 1884. It is hardly to be expected that another such exhibition will be made until the holding of the Chicago World's Fair in 1893.

THE CENTRAL STATION PROBLEM OF TO-DAY.

The presidential addresses delivered in the past before the National Electric Light Association have for the most part dwelt upon the past and present state of the industry which the Association is intended to foster, and in more than one instance pointed out the lessons to be drawn from the experience gained. In this respect, however, we believe none has surpassed in suggestiveness the admirable address of President Huntley delivered at Montreal. Being himself an eminently practical man, and addressing those whose chief business aim is to make money for their stockholders, rather than to discuss the abstract scientific principles of the apparatus which they handle, President Huntley very properly pointed out what seemed to him likely to be the future course to be pursued by central station managers. One striking point alluded to was, that it was not wise for the central station manager to look too far ahead in laying plans for the future, and we are certain that all will be impressed with the comparatively short-time limit which Mr. Huntley sets, and beyond which he deems preparations for the future should not be made. It is well, indeed, that Mr. Huntley has given prominence to this point, for the work which is now in progress, and other work which is bound to develop, may so greatly increase the capacity of our central stations, so far as lighting is concerned, as to certainly warrant some conservatism in this respect. In utilizing the means at command at the present time, Mr. Huntley also expresses undoubtedly sound views on the mode of distribution which will lead to the highest economy of operation. Without restricting himself to any particular style of current, he points out the great utility of the "zone system," an excellent idea as applied to electric distribution, and which, we think, will be carried out in practice in one form or another as its merits become better understood. We believe the opinion expressed by Mr. Huntley as to the relative merits for general distribution and utility of the continuous and alternating current, will probably find some opposition from the friends of the latter, but Mr. Huntley states, distinctly, that he views the subject entirely from the standpoint of the station manager who has to use apparatus furnished to him by the electrician. If, as it would seem according to Mr. Huntley, the alternating current is not yet able to give us all the service rendered by the low tension continuous current, it ought to be the aim of those interested in the progress of the latter to supply this want without delay, and we are certain that the energies which have been applied in bringing the alternating current to its present state of utility, will be equal to placing the same beside the continuous current in every essential feature. Altogether Mr. Huntley's address proves that he is a keen observer of events, and his views on the subjects treated will be read with interest by everyone interested in the progress of the art.

THE ELECTRICAL CENSUS.

There was, perhaps, no subject brought before the Convention which commanded more immediate attention and, indeed, aroused more energetic action than the announcement that the Superintendent of the Census had ordered the cessation of work on the preparation of the electrical census. It would be needless to repeat the reasons why this work should be prosecuted with the utmost degree of diligence, and the work which Mr. Allen R. Foote had already accomplished in this direction was a sufficient guarantee of the fact that the electrical section of the eleventh census would be a compilation of which America could be proud, and which would be of incalculable benefit to every one engaged in the industry. To stop such a work, now fairly begun, at this time, would be a positive disgrace, not to speak of the waste of money entailed in the expenditures already made upon it up to date. Even if the work should be taken up at some future time, the rapid strides which the industry is making would make the figures obtained a year or even six months from to-day entirely out of accord with those existing at, and gathered up to, the present time, so that the conclusions to be drawn from the census would be warped to that extent. All considerations of economy as well as of accuracy call for the uninterrupted prosecution of the work undertaken by Mr. Foote, and every effort should be made to induce Mr. Porter to rescind his recent order, and, if unavailing, Congress ought to be prevailed upon to appropriate the necessary funds. The committee having this matter in charge cannot act too quickly nor too energetically.

Fuses on Alternating Circuits.

The discussion on Mr. T. Carpenter Smith's paper read at the Providence Convention last February, while it could hardly be called adequate, considering the large number of details treated of by Mr. Smith, nevertheless served to bring out one or two points which ought to receive immediate attention. Perhaps the most important was the nature of the fuses employed in the alternating current systems, and the difficulties which accompany their use, as described by several members. It would thus seem that the action of the alternating current has a disintegrating effect upon the fuses, which causes them to blow after comparatively short use and thus necessitates a constant renewal and supervision of the circuits. This action should, we think, be thoroughly investigated and the proper remedy applied. As Mr. Smith pointed out, the electric light cannot be said to be firmly established in any place until operated so that there is no interruption of the current—not even for an instant. It is doubtful whether every station now operating can refer to a continuous uninterrupted run of all circuits for as short a time probably as a month. It would seem also that not a little difficulty is experienced by the loosening of screws in the converter, no doubt due to the internal vibration caused by the changing magnetism of the transformer core. These and other defects will, in time, be thoroughly eliminated, but it is just as well to have them pointed out now, so that the remedy may be applied as soon as possible.

The Ideal Electric Motor.

While the electric motor of to-day leaves little to be desired in the way of efficiency and regularity of operation when designed for a particular work in a stationary position, it cannot be denied that in some applications involving a change both in speed as well as in power at frequent intervals, such as occur particularly in railway work, difficulties are met with that reduce the economy of operation materially. A motor, therefore, which can operate at any speed, from zero to the maximum, and likewise at any given torque or pull over the same limits, and always at its maximum economy, will be conceded to be an achievement of no little value, and one which must make itself felt wherever electricity is applied to motive purposes. Judging from the demonstration given at the Montreal Exhibition, it would seem that such a motor is now actually available. The details of the principles upon which this motor operates are not yet available for publication, but we await with interest the paper which Mr. H. Ward Leonard, the inventor of the motor, will read before the American Institute of Electrical Engineers at an early date.

THREE YEARS' DEVELOPMENT OF ELECTRIC RAILWAYS.[1]

BY CAPT. EUGENE GRIFFIN.

THE first recorded description of the electric car is found in the fourth verse of the second chapter of Nahum: "The chariots shall rage in the streets; they shall jostle one against another in the broadways; they shall seem like torches, they shall run like the lightnings." Notwithstanding this early mention, it was not until 1888 that the electric railway became a practical commercial success. I fix the date at 1888 as it was in that year that Bentley and Knight opened the Allegheny City road to regular traffic; that the Sprague Company equipped the Richmond road, and the Thomson-Houston Co. installed the Eckington and Soldiers' Home road in Washington. It was in 1888 that railway officials began to realize the possibilities of this new tractive force; that the great West End system of Boston adopted electricity to the exclusion of cable, and that orders began to flow in upon the electric companies for street car motors to such an extent as to soon make the manufacture of such motors one of the leading branches of the electric industry.

The pioneers who devoted their brains and frequently their purses to this work previous to 1888 are deserving of all credit. It was their misfortune, not their fault, that their ideas were not developed and worked commercially. It is difficult for one man to combine the qualities of inventor, manager, superintendent, seller, expert and financier, and yet this is what Van Depoele, Daft, Bentley and Knight and others had to attempt. The record of their efforts is an interesting one, but the chronological record of electric traction has been so frequently given that it would be a waste of your time to repeat it again.

During the Toronto Annual Exhibition, in 1884, an electric railway some 3,000 feet long was operated from the entrance to the grounds to the main building. This was a conduit road and the wires carried a potential of over 1,000 volts without accident. A thirty horse-power electric locomotive was used hauling trains of cars.

The Van Depoele Company subsequently equipped roads at Minneapolis, Minn., Montgomery, Ala., Detroit, Mich., Windsor, Ont., Appleton, Wis., Port Huron, Mich., Scranton, Pa., Lima, O., Binghamton, N. Y., Ansonia, Conn., Dayton, O., Jamaica, N. Y., St. Catherines, Ont., and elsewhere, many of which are still in operation.

In the fall of 1887 Frank J. Sprague contracted for the electrical equipment of the Union Passenger Railway at Richmond, Virginia. This was an important road in a large city and Mr. Sprague's undertaking was the most ambitious effort in this direction up to that date. It is worthy of note that Sprague's original intention was to use motors with but one reduction, but he was forced to abandon this idea as none of the electrical companies at that date were able to produce single reduction motors. The motors used at first were too light for the work; the copper brushes scored the commutators badly and were rapidly consumed. Nevertheless, Mr. Sprague persevered despite all obstacles, and in 1888 the road was running with so much success that it was one of the object lessons which induced Henry M. Whitney and his brother directors of the West End Street Railway of Boston to adopt electricity as a motive power when they were already far advanced in the plans for cabling their system.

As nearly as can now be ascertained the following electric roads were actually in operation on January 1st, 1888:

Roads.		Location.	Miles.	No. of Mtr. cars.
Union Pass. Ry. Co..........	(Daft)............	Baltimore, Md.....	2.00	3
Windsor Electric Ry........	(Van Depoele) opp.	Detroit, Mich......	1.25	2
Appleton do	do.	Appleton, Wis....	5.50	5
Port Huron do	do.	Port Huron, Mich..	2.75	4
Highland Park..............	(Fisher)............	Detroit, Mich......	3.25	4
Scranton Suburban road.....	(Van Depoele).....	Scranton, Pa	5.00	12
Los Angeles Electric Ry. Co.	(Daft).............	Los Angeles, Cal..	5.00	6
Lima Street Ry. and Motor Power Co................	(Van Depoele). ...	Lima, Ohio........	4.00	8
Columbus Consolidated Street Ry......	(Short).	Columbus, O	1.00	2
St. Catherines Street Ry. Co.	(Van Depoele)....	St. Catherines, Ont.	7.00	13
Seashore Electric Ry. Co....	(Daft)..............	Asbury Park, N. J.	4.00	18
San Diego Street Ry. Co.....	(Henry)	San Diego, Cal....	3.00	9
East Harrisburg Pass Ry.Co	(Sprague)....... ..	Harrisburg, Pa....	4.40	10

A total of 13 roads, 48.25 miles of track and 95 cars.

On July 1st, 1891, there were 354 roads in actual operation, with 2,893 miles of traek equipped electrically, and 4,513 motor cars. Such has been the growth of three and a half years.

During the past spring the legislature of the State of Massachusetts was considering a proposition which practically amounted to the imposition of new taxes upon the West End Street Railway Co., and the abrogation or virtual annulment of certain vested rights which the company might claim. In his able and vigorous defense of his corporation, President Whitney was forced to investigate and determine the true relations which existed between his company and the public, and he was surprised himself to see how closely the welfare of the city of Boston and its surrounding suburbs was identified with the welfare of its street transportation system. He at once entered upon a "campaign of education," and his speeches in Somerville, Roxbury, Dorchester and elsewhere (several of which have been published in pamphlet form) are masterly, impressive, straightforward and convincing presentations of the close relations which existed between the rapid transit systems and the health, wealth, morality and prosperity of our large cities. I commend these speeches to the consideration of you all. I have not hesitated to draw from them largely myself.

I consider this growing realization of the true position which transportation companies occupy in respect to the public as one of the most important of recent developments, and it may be well to give it some consideration.

The last census has clearly shown a strongly-marked tendency of our population to gravitate towards the large cities. In every State the percentage of growth in cities is far greater than in towns and villages. Such condensation of population means an increase of the tenement house system in contradistinction to the cottage system, a crowding of people beneath each roof, and increase in vice, immorality, misery, crime and the death rate. How is it to be avoided? The laborer must live near his work, near in time and near in money. He can spare but a fraction of his time, but a fraction of his day's wages in going to and from his work. If the zone fare system exists as in Europe, the area within which he can live is limited by this consideration. Two cents per mile might restrict him to a radius of 2½ miles (5 cents). If the single-fare system prevails, as in this country, time is practically the only restriction. Let us assume that he can allow thirty minutes morning and evening for his car ride, paying five cents for each ride. At the rate of six miles per hour, fast for horses, he has a radius of three miles and an area of 28¼ square miles within which to select a home. At the rate of nine miles per hour, slow for electricity, he has a radius of four and a half miles and an area of 63¼ square miles within which to select a home. This example suffices to illustrate the point. An increase of only three miles per hour in rapidity of transit doubles the available residence area without increasing the time or expense of the laborer in going to and from his work.

The steam road, the elevated road, the underground road and the cable, each and all afford rapid transit; but their application is restricted within very narrow limits because of their great cost, while the electric roads can be profitably extended in all directions.

The objections to overhead wires have been, and in many places still are, very strong; but actual experience has shown that the objections are not well founded. Wires are not an ornament to the street, and objections on this ground will always exist; but lamp-posts, signs, railway tracks, and many other similarly useful objects are not ornaments. Overhead wires will never be condemned on this ground alone. Objections on the score of unsightliness become of less and less importance each year as the methods of construction are improved and the public appreciate more freely the benefits of electric motive power.

One of the early apprehensions in reference to the use of overhead wires was the possible danger to life from the current used. On this point I think the public are now well satisfied. While there are few employés on any of the roads now in operation who have not had the full shock of 500 volts repeatedly, there is not a single instance of any of the patrons of these roads who have been killed or even seriously injured by the 500 volt current from the overhead wire. Electric cars will run over and kill the careless pedestrian or the drunken passenger who falls from the platform in front of the wheels as will the horse car, but no passenger or pedestrian has ever been killed by the trolley wire, and statistics do not show that the electric car is in any respect more dangerous to life than the horse car or cable car. Last year (1890) the West End street railway system of Boston carried 114,853,081 passengers and all the steam railroads of the whole State of Massachusetts only carried 98,843,712. The West End system killed 15 passengers and employés and the steam roads killed 325. Of the 15 fatal accidents on the West End system, 5 were attributable to electric cars and 10 to horse cars. It is only fair to say that the narrow and crooked streets of Boston and the enormous traffic of the West End system are conditions peculiarly conducive to accidents. The fear of the electric current is one born of ignorance and time alone can overcome it.

In the year 1889, nine human beings were killed by the arc light wires in New York City (2,500 volts) and the authorities were roused to such a pitch of frenzy that the poles were chopped down and a large part of the city left in darkness. Yet, with perhaps one exception, all of the victims were employés of the lighting companies and suffered because of failure to observe proper and well-known precautions. In the same year, twelve persons were asphyxiated by gas and over thirty were killed by signs and other objects falling on their heads as they walked peacefully along the streets. In time we are able to estimate every danger relatively,

1. Abstract of a paper read before the N. E. L. A., Montreal, Sept. 10, 1891.

but in the beginning unknown dangers, those to which we are not accustomed, are greatly exaggerated.

The double and single trolley systems have each had ardent advocates, but three years' experience has decided the question in favor of the single trolley and the ground return.

In July, 1888, several roads were using the over-running trolley and it was a question whether the over-running or under-running system was preferable. Three years have decided this question also, and practically all of the electric roads of to-day operate with under-running trolleys. The "fish pole" of 1888 has been supplanted by the neat steel rod of 1891, and the "broom-stick train" can no longer be spoken of with disrespect as regards outward appearances.

Three years have not passed without much litigation and already we have historical cases finally determined, which tend to fix the legal boundaries of the rights of electric railways. Some of these decisions are of great importance.

The telephone companies have quite naturally been ardent advocates of the double trolley, and to avoid suffering from the induced currents of the single trolley, they have sought to induce the courts to compel railway companies to use metallic circuits. The recent decision of the Supreme Court of the State of Ohio is a fair statement of the present legal aspect of this question.

The telephone companies have been beaten in every case, and the fact has been definitely settled that railway companies may use a single overhead trolley wire and a ground return without infringing any rights of the telephone companies.

Many interesting legal questions have arisen in reference to line construction. Objection was made by the summer residents of Newport to the construction of an overhead electric railway, and eminent counsel was employed to place every possible legal obstacle in the way. The case was carried to the Supreme Court of the State of Rhode Island for determination of some of the novel points involved, and its decision was in favor of the electric railway company.

In the purely technical field all obstacles have been overcome. Like Perry, "We have met the enemy and they are ours." The severe strain imposed by railway work on the generating plant has necessitated the development of new types of engines and the fluctuations of the dynamos have been prevented by compound winding and series coils. Self-regulating dynamos are now considered necessary in any well-planned power plant.

The difficulties Mr. Sprague encountered in Richmond in using copper brushes have now been avoided by the introduction of the carbon brush, for which we are indebted to Mr. C. J. Van Depoele. As early as 1883-4 Van Depoele used carbon brushes with his motors. When the Van Depoele Electric Manufacturing Co. was purchased by the Thomson-Houston Co., in 1888, Van Depoele went to the Lynn factory of the latter company. Many did not then consider the carbon brush as practicable, and it was some time before Mr. Van Depoele had an opportunity to demonstrate its possibilities. When the time did come its great value was so apparent that it was at once adopted for motor work and subsequently has been used exclusively with generators.

Since the general adoption of the present method of mounting the motors directly on the axles, double reduction motors have been used. The supposed necessity of high speed of revolution in the armature made this obligatory. In 1890 it was found practicable to make motors in which the armature revolved at a slower rate and a single gear sufficed for the now greatly reduced reduction. From 10 and 12 to 1 with the old motor we come to 4½ to 1 with the new motor. The gears are enclosed in boxes and run in oil so that the noise has been reduced to a minimum, the offensive noise of the gears being practically eliminated. We have also gearless motors with no reduction and no gears.

Generator construction has kept pace with the improvements. As large stations have been built generators have increased in size, and electrical companies are now producing 500 h. p. dynamos as readily as the steam engine builders respond to similar demands.

We have learned what it costs to operate electric railways and the result is gratifying. In 1888 it was prophesied that while electric roads might make good showings so long as the apparatus was new and curiosity riding lasted, in a short time the machinery would begin to wear out and the roads would be swamped by the great repair bills. In reality we find the almost universal testimoney is that the longer the road runs, the less is the cost of repairs. This is, of course, not due to the fact that the apparatus improves in quality with age, but the explanation is to be found in the very simple fact that as small defects are eliminated and the employees become more experienced and the organization is perfected, the apparatus is better cared for and injuries are prevented.

A very conspicuous example of this is the West End Street Railway, which has been under my own immediate observation. In the contract between the Thomson-Houston Electric Company and the Railway Company it was provided that we should keep the overhead line and electrical apparatus on the cars in repair at a given price per car mile. There were many reasons which influenced us to enter such a contract, but the chief reason was that this was the uncertain element in the operation of an electrical railway, and unless this uncertainty could be eliminated, the West End would not make any contract. The cost of these repairs has steadily decreased, and on the 1st of October the West End Company avail themselves of their option and relieve us of this part of our contract, knowing there is now no uncertainty and that they can do the woık themselves for less money than they pay us.

Some months since President Whitney gave to the public the detailed figures showing the receipts and operating expenses of the West End road. These are of very great interest to all, and I give them in full for the purpose of drawing some conclusions from them :

THE ELECTRIC SYSTEM.

	April.	May.	June.	July.
Gross receipts	$134,321	$1446,38	$153,968	$144,552
General expenses	8,193	7,793	7,465	6,955
Track and car expenses	47,447	45,443	39,629	43,891
Motive power	20,194	30,924	26,359	26,398
Total op. expenses	85,834	84,163	73,459	77,249
Net earnings	48,487	60,475	80,529	67,308
Miles run	394,459	376,821	360,567	377,191
Ratio of mileage	26.68	25.58	25 15	25.19
Per cent. op. expenses	63.36	58.18	47.70	53.44
Earnings per mile run	34.05	38.43	42.71	38.32
Expenses per mile run :				
Motive power	07.65	08.22	07.81	07.00
Car repairs	01.39	01 33	01.18	01.17
Damages	00.75	00.89	00.16	00.12
Conductors and drivers	07.33	07.36	07.25	06.92
Other expenses	04.63	04.56	04 47	05.37
Total expenses per mile run	21.75	22.36	20.87	20.48
Net earned per mile run	12.30	16.07	22.34	17.84

HORSE CAR SYSTEM.

	April.	May.	June.	July.
Gross receipts	$344,396	$374,605	$395,555	$409,878
General expenses	22,514	22,682	22,217	20,657
Track and car expenses	136,693	127,902	125,398	135,954
Motive power	117,740	118,972	116,210	116,271
Total op. expenses	276,947	269,556	263,825	272,888
Net earnings	67,449	105,049	131,729	136,990
Miles run	1083,887	1094,683	1073,718	1120,377
Ratio mileage	73.32	74 42	74.85	74.81
Per cent. op. expenses	80.62	71.95	66.70	66.58
Earnings per mile run	31.77	34.22	36.85	36.58
Expenses per mile run :				
Motive power	10.86	10.86	10.83	10.38
Car repairs	00.98	00.60	00.61	00.61
Damages	00.78	00.87	00.15	00.06
Conductors and drivers	08.24	08 24	08.25	08.23
Other expenses	04.70	04.55	04.24	05.07
Total expenses per mile run	25.55	24 62	24.58	24.35
Net earned " " "	06.22	09.60	12.27	12.23

THE ENTIRE SYSTEM.

	April.	May.	June.	July.
Gross earnings	$478,717	$519,244	$549,543	$554,431
General expenses	30,707	30,478	29,683	27,613
Track and car expenses	184,141	173,344	165,027	179,853
Motive power	147,933	149,896	142,570	142,670
Total op. expenses	362,781	353,720	337,284	350,137
Net earnings	115 935	165,524	212,250	204,294
Miles run	1478,346	1471,004	1433,785	1497,568
Ratio of mileage	100	100	100	100
Per cent. op. expenses	76.82	68.12	61.37	63.15
Earnings per mile run	32.39	35.29	38.33	37.02
Expenses per mile run :				
Motive power	10.01	10.19	09.94	09.53
Car repairs	01.05	00.79	00.76	00.75
Damages	00.77	00.50	00.15	00.07
Conductors and drivers	08.03	08 01	08.00	07.91
Other expenses	04.68	04.55	04.67	05.12
Total expenses per mile run	24.54	24.04	23.52	23.38
Net earned per mile run	07.85	11.25	14.81	13.64

Taking the June figures, it will be noticed that the net earnings per electric car mile exceed the net earnings per horse car mile by 10.07 cents, while the operating expenses of the horse car lines exceed those of the electric car lines by 4.20 cents per car mile. The difference is 5.86 cents per car mile, which is the gain to the company due solely to the public satisfaction with the electric service. Mr. Arthur Jones of the T. H. International Co. first produced this figure which he calls the "satisfaction figure."

The net earnings per electric car mile exceeded the net earnings per horse car mile by the following amounts :

In April	6.08	cents	per	car mile.
" May	6.47	"	"	"
" June	10.07	"	"	"
Mean	7.54	"	"	"

The net earnings of the horse cars for the three months averaged 9.36 cents per car mile, hence the electric cars showed a gain of 80 per cent. in the net earnings per car mile over the horse cars.

For the three months, we have the following figures for the electric cars :

Total receipts	$432,947
" expenses	243,456
Percentage of expenses to receipts	56 p. c.

In St. Paul and Minneapolis, with a combined population of 350,000, there is to-day not one single horse car. Minneapolis has 120 miles of electric railways, all equipped with the overhead system, and St. Paul has 75 miles of electric railways and 15 miles of cable. Most of the cable mileage is to be abandoned and supplanted by electricity. The last car horse disappeared from the streets of Minneapolis in June of this year. The July report of the Minneapolis system shows:

Gross earnings	$107,571
" expenses	52,585
Net earnings	54,985
Percentage of expenses to receipts	49 p.c.

Cleveland, Buffalo, Rochester, Toledo, Omaha, Cincinnati and many other large cities are now operating their street cars almost exclusively with electric motors, and the universal testimony is favorable to the increased facilities afforded the public and the increased profits to the stockholders.

Not the least important of the developments of the last three years has been the financial development. The fine showings as to earnings, the gradual decrease in operating expenses, where increases were expected, the oft demonstrated ability to run electric cars in all kinds of weather, in ice, snow, sleet, hail or rain has greatly improved the standing of electrical securities. An electric road is no longer an experiment, it is a paying investment and there are not a few instances where the introduction of electricity has been the salvation of a horse road that otherwise would soon have been in the hands of a receiver. The rapidly increasing demand for electrical securities is an evidence of a healthy growth of public sentiment in this direction. To equip electrically means the expenditure of money which must come from an increase of the bond or stock issued. The ability of the public to rapidly absorb these new bonds or stock must be the ultimate limit of the ability of the railway companies to move in this direction.

In August the West End Street Railway Company put out four millions of common stock for additional electrical equipment under a plan of subscription which provided for two deferred payments. When the subscription books were closed on the 5th of August, 33,000 shares had been paid in and only a paltry 245 shares had taken advantage of the option for deferred payments. I know of no more striking object lesson than this, except perhaps the rapid rise of the West End common stock from 63 to 77, which immediately followed.

Electric securities have heretofore been offered at tempting figures, but the day for this is passing. The public are realizing that a good street railway security is better than a Western railroad bond or stock, and the electric roads are better than the horse roads. Electric railways will pay where no one would dream of building a horse road, and when the public taste is whetted for electrical securities, we shall see a marvelous increase in the number of roads and the equipment of existing roads that will mean transportation facilities for thousands who are now unprovided, and many years' work for our electrical factories.

SOME DETAILS OF THE CARE AND MANAGEMENT OF AN ARC LIGHTING SYSTEM AS PRACTICED IN THE "MUNICIPAL," OF ST. LOUIS.[1]

BY J. I. AYER.

As central station men, it seems to me that we should demand of each other as much knowledge of the practice and experience as is practicable to give. In fact, if this Association is to be useful, our meetings should be largely "experience meetings," and the practical experience of those engaged in the development of the lighting and kindred industries, if given liberally at each meeting, would be followed closely by those interested in the production of electrical apparatus and supplies, and would do much to advance the business and improve appliances. Believing that we are here, as central station managers, for mutual improvement and for the free interchange of ideas and experience, I have presumed to present you with a limited, though doubtless dry, outline of the practice which obtains in the central station under the writer's charge.

The station, as designed, has a working capacity of 6,000 arc lights, and is now operating daily 3,500, and about 200 constant current motors; 2,000 of these lights are distributed over an area of 60 square miles, suspended between and from poles 50 and 65 feet in length, at a height of from 35 to 50 feet above the roadway, an average distance apart of about 900 feet, and used for street lighting. The motors and about 1,500 lamps are operated for the usual varied service of private consumers; 69 circuits supply the lamps and motors, containing about 1,200 miles of wire and supported on 12,000 poles.

For generating the current, we have six 600 h.p. Corliss engines, which drive 300 feet of shafting, from which are driven sixty-five 60 light and twelve 80 light, 2,000 c.p. arc dynamos. The arrangement of the dynamos is such that we have ample room for the care of 85 machines on a floor space of about 100 x 45 feet, and are able to operate a large number of dynamos with a very limited amount of help. Four boys and one young man of very limited experience care for all the machines during the night, in an entirely satisfactory manner; while a suitable man, with three assistants, give the necessary care to the dynamos during the day.

Thirty-one trimmers, with horses and carts, travel about 500 miles a day to renew the carbons in the street lamps. The average number of lamps to each of these trimmers is 68. Sixteen trimmers care for the 1,500 commercial lamps. Five inspectors, or trouble-men, with carts and horses, care for the lines night and day, answer fire alarms, locate faults and correct minor troubles on the lines. Two day and two night inspectors care for the commercial arc and 2,500 incandescent lamps. A stable of 20 horses, in addition to the 40 horses owned by the trimmers and inspectors, is required. The maintenance of 60 vehicles justifies a blacksmith and wagon shop, which, with the stable, require the services of eight men. Two men care for the shafting and three engineers and four oilers for the engine room. In the boiler house, where there are nineteen 300 h.p. boilers, there are two pump men, with two assistants, twelve stokers, one boiler cleaner, and six coal shovelers. These, together with an average force of 35 line and ground men, foreman, chief trimmer, chief inspector, superintendent of lines, store keeper, repair shop employees, carpenters, clerks, etc., constitute a force of about 170 men. A very large per cent of these men are called upon to perform duties which are simple, yet, because of their extreme newness, are not thoroughly comprehended by them. To get the best results, each man requires clearly written rules, as few of them as possible, and their rigid enforcement. In all practice this is the wise way to put it; but it is absolutely necessary that it be so with a large force, where many of the men do their work independently, and free from the constant supervision of a foreman.

In the room used as an office at the station by the inspectors and formen are city maps, mounted on boards, where the locations of the lamps are indicated by tacks and the circuits by strings. For the central part of the city, where there are many circuits on the same line of poles, each circuit is shown on a separate map of that section. A number of printed slips, which represent a pole with cross arms, indicate the location of the wires on the poles on the different streets traversed by the different circuits. Any change of circuits is noted on a separate blank when the work is ordered, and when completed the maps are corrected to correspond. It takes but a few days for a man to become quite familiar with the circuits, by keeping them so conspicuously placed. In large stations this method of indicating circuits is almost indispensable, and will prove of great value if used in smaller ones.

For testing purposes we have a portable tachometer for indicating speeds, two Thomson indicators for the engines, a recording steam gauge, two standard ammeters and a voltmeter reading to 5,000 volts for the dynamo room; on each circuit a spring socket for attaching ammeters and a current indicator for indicating the direction the current is flowing through the circuit; near the lightning arresters on the upper floor, a switch-board specially arranged for testing only; a Wheatstone bride, magneto bells, etc. The engines are indicated once each day.

Evaporation boiler tests are made every month to see that the quality of coal is maintained at the standard. All the circuits are tested four times each day. All live circuits during the day are tested for grounds, and all others for apparent open circuits as well. In addition to this, all circuits are tested while alive by taking volt and ammeter readings simultaneously. The number of miles of wire and number of lamps being known, any material increase in the energy consumed gives evidence of a fault not always easily discovered by other methods. In testing for grounds on circuits not alive, a strong magneto bell is used. For all other testing a battery current of from 30 to 50 volts is used, and the circuit is required to pass at least one ampere to operate an ordinary call bell. When this bell is placed in series with a circuit which has more resistance than will pass this current at the pressure, the circuit is at once inspected and the fault located. In locating the trouble, one side of the bell circuit is connected to the line and the other to earth. The inspector or trouble man carries a similar bell with him, which he connects in series with the earth and line at various points, until the fault is located. The value of circuit testing with low voltage is keenly appreciated by those who have practiced it. When the circuits are alive, ammeter readings are recorded every two hours, and all readings are from the same instruments. These instruments are arranged so as to be read singly or in series, and one is used to check the other. The value of first-class instruments in plants of any size cannot be overestimated, and should be in daily use in all stations, rather than the makeshifts generally supplied.

The stopping and starting of engines and boilers, pumps, dynamos, circuits, etc., are all recorded on reports made by those in charge of the different departments. Each inspector, trimmer, line foreman, storekeeper, and all heads of departments make daily reports of work done, and time and material used by them. Each trimmer is charged with a certain number of demerits for

1. A paper read before the N. E. L. A., Montreal, P. Q., Sept. 10, 1891.

each fault on his route, such as defective or dirty lamps, broken or dirty globes, carbons used in excess of the required number, etc., and each month prizes are awarded to those having the best records.

The advantage of using vehicles for trimmers for all street-lighting work is being recognized. Provide a man with proper appliances and your service will improve. He cannot carry all that he should and walk long distances, nor will he take the same care when he is worn out with tramping that he otherwise would. We find it desirable for the trimmer to own and care for his own horse, while the company provides a suitable vehicle and harness, which he turns into the stable once a week for inspection, cleaning and repairs, when needed.

We select from our linemen those whom we class as inspectors or trouble men, who are equipped with a light-running cart, with a suitable place for the storage of all tools necessary to use in an emergency. In addition to the special duty required of them during storms or at fires, these men correct all minor troubles reported to the office from various sources. During the first year's operations the average time lost, due to open circuits at night—that is, the average time lost from the time the circuit was opened until it was closed and the lights restored—was an hour and five minutes, notwithstanding that all circuits are more than ten miles in length. When these troubles occur, it is almost always during a storm, but the conveyances with which they are provided and their thorough knowledge of the circuits enable them to become very expert in locating and correcting troubles. During the past year nearly 15 per cent. of all the calls answered by our trouble men were to correct troubles on the lines of other companies. Because we have wires all over the city, the police, and the public generally, think that all the wires belong to us, and, when they discover any trouble with them, are very apt to report the same by telephone to our station. During the entire twenty-four hours there is always one man on duty, ready to answer just such calls and correct the troubles.

All arc lamps, before leaving the station, are placed in a test rack, where they are supplied with a current maintained absolutely constant. Voltmeter readings are noted soon after the lamps have been lighted, when the carbons are about half consumed, and also when they are burned quite short. During the early part of the burning the lamp is adjusted so that the readings, taken at three different points, give an average reading of 46 volts. In case of double lamps, this work is carried out on both rods. This extreme care in regard to adjustment we regard as absolutely necessary. If a lamp is permitted to consume its carbons, any fault which would not be discovered with a brief test is quite likely to develop. To determine the length of arc by the current and voltage is more likely to result in uniform lamps then where tested by the eye. With ten lamps, adjusted to burn at an average of 46 volts, with $9\frac{5}{10}$ amperes, the average number of watts per lamp was 436. Without changing the adjustment of the lamps, the current was increased to $9\frac{8}{10}$ amperes, and there was an average consumption of 524 watts per lamp, an increase of 20 per cent. of energy; and by increasing the current to ten amperes, the average number of watts per lamp was 550, the average voltage 58, the increase above normal being 33 per cent. That means 33 per cent. more coal, 33 per cent. more work at your dynamo, 33 per cent. less capacity in your dynamo, and probably 33 per cent. less life in your armature. One is apt to think that the difference between $8\frac{5}{10}$ and 10 amperes, when supplied to the lamp, is only a difference of 5 or 10 per cent., which is not very serious. This would be true if the lamp were adjusted each time for the ampere current it was to be operated with. To those who have not made this experiment, perhaps, a portion of the mystery as to where the coal goes will be cleared up. By using the ammeter and voltmeter for adjusting the lamps, and then seeing that the circuits are provided with the same ampere current indicated by the same ammeter, one will be apt to bring about like conditions in all lamps; at least, they are more likely to be uniform than if independent ammeters are used on each circuit. By reference to this statement relative to the amount of energy consumed by change of current, it will be easy to see how expensive one or two low lamps would be on a circuit, where the operator, to correct the trouble, supplies them with current enough to make them bright. Of course it is understood that better service as well is obtained by operating the circuits with no more current than that for which the lamps are adjusted. In this connection, I believe it is proper to again call attention to the well-worn subject of connections. A great deal of time and trouble is spent in soldering joints, and when the lines are led to the lamp they are apt to be poked into the binding posts, held with set screws indifferently tightened, and between these binding posts and the lamp connections proper there are perhaps three or four, if not more, indifferent contacts, all of which look very well in the factory, but are very bad after a few months' service. Hanger-boards should be used which have the line wire soldered to connections which cannot get loose. In our practice we accomplish this by using about 18 inches of flexible insulated cable, which is soldered to the hanger-board binding posts at the station (cut-out boxes are treated in the same manner) leaving the lineman nothing but an ordinary line joint to make, which can be easily done outside. Where lamps are suspended from the hanger-boards by the hooks which conduct the current, we always insist on some character of second connection being made to the lamp besides this. A simple way to do this is to take some small wire and tie the hook to the loop, in much the same manner as you would with a piece of twine. We have no screw connections anywhere in our circuits, and with a little ingenuity and care, they can be avoided always in arc lighting circuits. By the use of a special socket in each circuit for connecting an ammeter, we are able to take the readings with volt and ammeter, and get a correct indication of the actual consumption of energy on a circuit while in operation. With the data relative to the number of lamps in service and the number of miles and size of wire, we are able to discover any excessive consumption of energy and prevent the development of a series of little faults, which, in a short time, grow to be very serious ones if permitted to continue. Usually these readings are taken on each circuit three times a week, and during the time these observations are made, indicator cards are taken from the engines. From these two sources we get the actual consumption of electrical energy per circuit and per engine. We also get the indicated horse power. From a set of eleven observations taken from July 30th to August 28th, at various hours during the night run, the station shows an efficiency, between indicated horse power and electrical horse power at dynamo terminals of 74.9 per cent., ranging from 70.3 per cent., the lowest, to 77.5 per cent., the highest efficiency shown. The circuit readings indicate an average consumption of energy per lamp of about 6-10 of an electrical horse power. The average indicated horse power is about 8-10 per lamp. A good condition of the circuits is maintained constantly, because any neglect in any department is quickly shown by the data obtained from our records. Some months ago, when press of business caused the measurement of circuits to be neglected for a few weeks, the writer discovered an increase of over ten per cent. in the consumption of fuel, when there should have been a slight decrease. An investigation showed that an accident to an ammeter had caused a false reading, which increased the cost of fuel alone about $16 a day. The difference in the appearance of the lamps was not such as to call forth special comments then by those interested, yet, when the fault was discovered, it was remembered that some seemed to have been burning high for a week or two. On suburban circuits on long loops, it is our practice to place cut-out boxes on the pole where the line branches. This saves a great deal of time in locating troubles; but, let me add, that unless a thoroughly water-tight and substantial cut-out is used, it will prove more of an annoyance than an advantage. A log of each circuit and dynamo, as well as of engines and boilers, is a very satisfactory and desirable part of the records, and will frequently assist materially in locating troubles and saving expense.

Throughout the country it is almost the universal practice to wire for arc lights without cost to the customer. There is no valid reason for this custom, and for more than a year it has been our custom to charge for cost of labor, with the result of reducing expenses more than $600 per month. In every case where lamps are discontinued in the spring, we require a contract for fall and winter service, else the wires are removed when the lamp is taken down. We invariably cut down the line between the house and pole where the service is discontinued for the season, though it is to be renewed later. To induce annual contracts, a rebate of five per cent. is given at the expiration of the year, and is found to work to advantage.

There are very many details of construction, as well as of office work, which could be referred to, if it were not that this paper is now too long; but I will be glad to furnish a copy of "general instructions to employees," used in the government of this plant, which refer to and bring out some points of management which are not mentioned here, to those who care for them.

REPORT OF THE N. E. L. A. COMMITTEE ON TABULATING WIRING AND INSURANCE RULES.[1]

CLASS A.—CENTRAL STATIONS.

FOR LIGHT OR POWER.

These Rules also apply to Dynamo Rooms in Isolated Plants, connected with or detached from buildings used for other purposes. Also to all varieties of apparatus, of both high and low potential.

GENERATORS OR MOTORS—Must be:

1. Located in a dry place.
2. Insulated on floors or base-frames which must be kept filled to prevent absorption of moisture, and also kept clean and dry.
3. Not exposed to flying or combustible materials.
4. Each covered with a waterproof cover when not operating.

In no case must a generator be placed in a room where any hazardous process is carried on, such as the working-room of a cotton, jute, flax, woolen or flour mill.

1. Presented and adopted by the National Electric Light Association, Montreal, P. Q., Sept. 10, 1891.

CARE AND ATTENDANCE.—A competent man must be kept on duty in the room where generators are operating.

Oily waste must be kept in metal cans and removed daily.

CONDUCTORS.—From generators, switchboards, rheostats or other instruments, and thence to outside lines, conductors must be:

1. 1. In plain sight.
2. Wholly on non-combustible insulators, such as glass or porcelain.
3. Separated from contact with floors, partitions or walls through which they may pass, by non-combustible insulating tubes.
4. Kept rigidly so far apart that they cannot come in contact.
5. Covered with non-inflammable insulating material sufficient to prevent accidental contact.
6. Ample in carrying capacity to prevent heating. (See Capacity of Wires Table.)
7. Connected by splices or joints equal in carrying capacity to the conductors themselves, soldered if necessary to make them efficient and permanent.
8. When under floors or in distributing towers, placed in spaces ample for inspection and ventilation, and provided with special insulating covering.

SWITCHBOARDS—Must be:

1. So placed as to make it impossible to communicate fire to surrounding combustible material; accessible from all sides when the connections are on the back; or may be placed against a brick or stone wall when the connections are entirely on the face.
2. Kept free from moisture.
3. Made of non-combustible material, or of hard wood, filled to prevent absorption of moisture.
4. Equipped with bars and wires in accordance with rules 1, 2, 4, 5, 6 and 7 for placing interior conductors.

RESISTANCE BOXES AND EQUALIZERS—Must be:

1. Equipped with metal or non-combustible frames.
2. Treated as sources of heat.
3. Placed on the switch or a distance of a foot from combustible material, or separated therefrom by asbestos or cement.

LIGHTNING ARRESTERS—Must be:

1. Attached to each side of every overhead circuit connected with the station.
2. In plain sight.
3. On the switchboard or in an equally accessible place, away from combustible material.
4. Connected with at least two earths by separate wires of large size.
5. So constructed as not to maintain an arc after the discharge is passed.

TESTING.—All series and alternating circuits must be tested every two hours while in operation to discover any leakage to earth, abnormal in view of the potential and method of operation.

All multiple arc low potential systems (300 volts or less) must be provided with an indicating or detecting device, readily attachable, to afford easy means of testing where the station operates perpetually.

Data obtained from all tests must be preserved for examination by insurance inspectors.

CLASS B.—ARC (SERIES) SYSTEMS.

OVERHEAD CONDUCTORS.—All outside overhead conductors (including services) must be:

1. Covered with some insulating material, not easily abraded.
2. Firmly secured to properly insulated and substantially built supports, all the wires having an insulation equal to that of the conductors they confine.
3. So placed that moisture cannot form a cross-connection between them, not less than a foot apart and not in contact with any substance other than proper insulating supports.
4. At least seven feet above the highest point of flat roofs and at least one foot above the ridge of pitched roofs, over which they pass, or to which they are attached.
5. Protected whenever necessary, in view of possible accidents to conductors or supports, from possibility of contact with other conducting wires or substances to which current may leak, by *dead insulated guard irons or wires.* Special precautions of this kind must be taken where sharp angles occur, or where any wires might possibly come in contact with electric light or power wires.
6. Provided with petticoat insulators of glass or porcelain. Porcelain knobs and rubber hooks are prohibited.
7. So spliced or joined as to be both mechanically and electrically secure without solder. They must then be soldered to insure preservation and covered with an insulation equal to that on the conductors.

The following formula for soldering fluid is approved:

Saturated Solution of Zinc..................	5 parts.
Alcohol................................	4 parts.
Glycerine................................	1 part.

Conductors should not be run over, or attached to, buildings other than those in which light or power is being, or is to be, used, but on separate poles or structures, always easily inspected.

SERVICE BLOCKS must be covered over their entire surface with at least two coats of waterproof paint and so maintained.

Telegraph, telephone and similar wires must not be placed on the same arm with electric or power wires and *should not* be placed on the same structure or pole.

INTERIOR CONDUCTORS.

ALL INTERIOR CONDUCTORS—Must be:

1. Where they enter buildings from outside terminal insulators to and through the walls, covered with waterproof insulation, and must have drip loops outside, preferably slanting upward toward the inside and bushed with water-proof and non-combustible insulating tube.
2. Arranged to enter and leave the building through a double contact service switch, which will effectually close the main circuit and disconnect the interior wires when it is turned "off." The switch must be so constructed that it shall be automatic in its action, not stopping between points when started, and prevent an arc between the points under all circumstances; it must indicate on inspection whether the current be "on" or "off," and be mounted on a non-combustible base in a position where it can be kept free from moisture, and easy of access to police or firemen.
3. Always in plain sight, never covered, except in special cases, where an armored tube may be necessary.
4. Covered in all cases with a moisture-proof non-combustible material that will adhere to the wire, not fray by friction, and bear a temperature of 150° F. without softening.
5. In dry places, kept rigidly apart at least ten inches, except when covered (in addition to insulation) by a water-proof, non-conducting and non-inflammable tubing, which must be strong enough to protect the insulation covering from injury. Conductors thus placed may be run not less than three inches apart, and be fastened with staples, under which are placed mechanically rigid insulating strips or saddles of greater width than the metal of the staple, by which possibility of injury to the tube may be prevented.
6. In damp places, attached to glass or porcelain insulators, and separated ten inches or more.
7. When passing through walls, floors, timbers or partitions, treated as in central stations under like conditions.

LAMPS AND OTHER DEVICES.

ARC LAMPS MUST BE IN EVERY CASE:

1. Carefully isolated from inflammable material.
2. Provided at all times with a glass globe surrounding the arc, securely fastened upon a closed base. No broken or cracked globes may be used.
3. Provided with a hand switch, also an automatic switch, that will shunt the current around the carbons should they fail to feed properly.
4. Provided with reliable stops to prevent carbons from falling out in case the clamps become loose.
5. Carefully insulated from the circuit, in all their exposed parts.
6. Where inflammable material is near or under the lamps, provided with a wire netting around the globe and a spark-arrester above, to prevent escape of sparks, melted copper or carbon.

Incandescent lamps on series circuits, having a maximum potential of 350 volts or over, must be governed by the same rules as for arc lights, and each series lamp provided with a hand switch and automatic cut-out switch; when lights are in multiple series, such switches and cut-outs must not control less than a single group of lights. Electro magnetic devices for switches are not approved.

Under no circumstances will incandescent lamps on series circuits be allowed to be attached to gas fixtures.

CLASS C.—INCANDESCENT (LOW PRESSURE) SYSTEMS.

300 VOLTS OR LESS.

OVERHEAD CONDUCTORS.

OUTSIDE OVERHEAD CONDUCTORS—Must be:

1. Erected in accordance with general rules for Arc (Series) Circuit Conductors.
2. Separated not less than six inches, where they enter buildings as ser ice conductors, and be provided with a double pole fusible cut-out, as near as possible to the point of entrance to the building, and outside the walls when practicable.

UNDERGROUND CONDUCTORS.

UNDERGROUND CONDUCTORS—Must be:

1. Provided with suitable protecting devices at the ends of tube or conduit services inside the walls of buildings, as a guard against moisture and injury.
2. Terminated at a properly placed double pole house cut-out.

3. Of specially insulated conductors after leaving the tube or conduit, and separated by at least ten inches, until the double pole cut-out is reached.

INSIDE WIRING.

Wire should be so placed that in the event of the failure or deterioration of their insulating covering, the conductors will still remain insulated.

At the entrance of every building there shall be a double pole switch placed in the service conductors, whereby the current may be entirely cut off.

CONDUCTORS MUST NOT BE:

1. Of sizes smaller than No. 16 B. & S., No. 18 B. W. G., or No. 3 E. S. G.
2. Lead or paraffine covered.
3. Covered with soft rubber tube.
4. Laid in mouldings of any kind in damp places.
5. Laid in mouldings with open grooves against the wall or ceiling.
6. Laid in mouldings where less than half an inch of solid insulation is between parallel wires, and between wires and walls or ceilings.

Mouldings, where admissible, must have at least two coatings of water-proof paint or be impregnated with a moisture repellent.

CLEATWORK is not desirable, and cleats must *not* be used unless:

1. In a very dry place.
2. In a place perfectly open for inspection at any time.
3. They are of porcelain, or well-seasoned wood, filled, to prevent absorption of moisture.
4. They are so arranged that wires of opposite polarity, with a difference of potential of 150 volts or less, will be kept at least two and one-half inches apart, and that where a higher voltage is used, this distance be increased proportionately.
5. There is a backing provided, of wood at least half an inch thick, well-seasoned and filled, to prevent absorption of moisture.

METAL STAPLES must never be used to fasten conductors unless

1. Provided with an insulating sleeve or saddle rigidly attached to the metal of the staple, and having such strength and surface as to prevent mechanical injury to the insulation of the conductor.
2. Under conditions in which cleatwork would be acceptable, or where driven into a moulding specially adapted for open work.

SPECIAL WIRING.

Wherever conductors cross gas, water, or other metallic pipes, or any other conductors or conducting material (except arc light wires), they should be separated therefrom by some continuous non-conductor at least one inch. In crossing arc light wires the low tension conductors must be placed at a distance of at least six inches. In wet places an air space must be left between conductors and pipes in crossing, and the former must be run in such a way that they cannot come in contact with the pipe accidentally. Wires should be run *over* all pipes upon which condensed moisture is likely to gather, or which by leakage might cause trouble on a circuit.

In breweries, dye-houses, paper and pulp mills, or other buildings specially liable to moisture, all conductors, except where used for pendants, must be:

1. Separated at least six inches.
2. Carefully put up.
3. Supported by porcelain or glass insulators.

Moisture proof and non-inflammable tubing may be accepted in lieu of such construction.

No switches or fusible cut-outs will be allowed in such places.

INTERIOR CONDUITS MUST NOT BE:

1. Combustible,
2. Of such material as will be injured or destroyed by plaster or cement, or of such material as will injure the insulation of the conductor.
3. So constructed or placed that difficulty will be experienced in removing or replacing the conductors.
4. Subject to mechanical injury by saws, chisels or nails.
5. Supplied with a twin conductor in a single tube where a current of more than 10 amperes is expected.
6. Depended upon for insulation. The conductors must be covered with moisture-proof material.

The object of a tube or conduit is to facilitate the insertion or extraction of the conductors, to protect them from mechanical injury, and, as far as possible, from moisture.

Twin tube conductors must not be separated from each other by rubber or similar material, but by cotton or other readily carbonizable substance.

Conductors passing through walls or ceilings must be encased in a suitable tubing, which must extend at least one inch beyond the finished surface until the mortar or other similar material be entirely dry, when the projection may be reduced to half an inch.

DOUBLE POLE SAFETY CUT-OUTS MUSE BE:

1. Placed where the overhead or underground conductors enter a building and join the inside wires.
2. Placed at every point where a change is made in the size of the wire (unless the cut-out in the larger wire will protect the smaller). This includes all the flexible conductors. All such junctions must be in plain sight.
3. Constructed with bases of non-conbustible and moisture proof material.
4. So constructed and placed that an arc cannot be maintained between the terminals by the fusing of the metal.
5. So placed that on any combination fixture, no group of lamps requiring a current of six amperes or more shall be ultimately dependent upon one cut-out.
6. Wherever used for more than six amperes, or where the plug or equivalent device is not used, equipped with fusible strips or wires provided with contact surfaces or tips of harder metal, soldered or otherwise having perfect electrical connection with the fusible part of the strip.

SAFETY FUSES must be so proportioned to the conductors they are intended to protect, that they will melt before the maximum safe carrying capacity of the wire is exceeded.

All fuses, where possible, must be stamped or otherwise marked with the number of amperes equal to the safe carrying capacity of the wire they protect.

All cut-out blocks when installed must be similarly marked.

The safe carrying capacity of a wire changes under different circumstances, being about forty per cent. less when the wire is closed in a tube or piece of moulding, than when bare and exposed to the air, when the heat is rapidly radiated. It must be clearly understood that the size of the fuse depends upon the size of the smallest conductor it protects, and not upon the amount of current to be used on the circuit. Below is a table showing the safe carrying capacity of conductors of different sizes in Birmingham, Brown & Sharpe, and Edison gauges, which must be followed in the placing of interior conductors.

BROWN & SHARPE.		BIRMINGHAM.		EDISON STANDARD.	
Gauge No.	Amperes.	Gauge No.	Amperes.	Gauge No.	Amperes.
0000	175	0000	175	200	175
000	145	000	150	180	160
00	120	00	130	140	135
0	100	0	100	110	110
1	95	1	95	90	95
2	70	2	85	80	85
3	60	3	75	65	75
4	50	4	65	55	65
5	45	5	60	50	60
6	35	6	50	40	50
7	30	7	45	30	40
8	25	8	35	25	35
10	20	10	30	20	30
12	15	12	20	12	20
14	10	14	15	8	15
16	5	16	10	5	10
		18	5	3	5

SWITCHES—Must:

1. Be mounted on moisture proof and incombustible bases, such as slate or porcelain.
2. Be double pole when the circuits which they control are connected to fixtures attached to gas pipes, and when six amperes or more are to pass through them.
3. Have a firm and secure contact, must make and break readily, and not stick when motion has once been imparted by the handle.
4. Have carrying capacity sufficient to prevent heating above the surrounding atmosphere.
5. Be placed in dry, accessible places, and grouped as far as possible, being mounted, when practicable, upon slate or equally indestructible back boards.

MOTORS.—In wiring for motive power, the same precautions must be taken as with the current of the same volume and potential for lighting. The motor and resistance box must be protected by a double-pole cut-out, and controlled by a double-pole switch.

ARC LIGHTS ON LOW POTENTIAL CIRCUITS—Must be:

1. Supplied by branch conductors not smaller than No. 12 B. & S. gauge.
2. Connected with main conductors only through double-pole cut-outs.
3. Only furnished with such resistances or regulators as are enclosed in non-combustible material, such resistances being treated as sources of heat.
4. Supplied with globes protected as in the case of arc lights on high potential circuits.

FIXTURE WORK.

1. In all cases where conductors are concealed within, or attached to fixtures, the latter must be insulated from the gas pipe system of the building.

2. When wired outside, the conductors must be so secured as not to be cut or abraded by the pressure of the fastenings, or motion of the fixtures.

3. All conductors for fixture work must have a water-proof insulation that is durable and not easily abraded, and must not in any case be smaller than No. 16 B. & S., No. 18 B. W. G., or No. 3 E. S. G.

4. All burrs or fins must be removed before the conductors are drawn into a fixture.

5. The tendency to condensation within the pipes must be guarded against by sealing the upper end of the fixture.

6. No combination fixture in which the conductors are concealed in a space less than one-fourth inch between the inside pipe and the outside casing will be approved.

7. Each fixture must be tested for possible "contacts" between conductors and fixture, and for "short circuits," before the fixture is connected to its supply conductors.

8. The ceiling blocks of fixtures should be made of insulating material.

ELECTRIC GAS LIGHTING.

Where electric gas lighting is to be used on the same fixture with the electric light:

1. No part of the gas piping or fixture shall be in electrical connection with the gas lighting circuit.

2. The wires used with the fixture must have a non-inflammable insulation, or, where concealed between the pipe and shell of the fixture, the insulation must be such as is required for fixture wiring for the electric light.

3. The whole installation must test free from "grounds."

4. The two installations must test perfectly free of connection with each other.

PENDANTS AND SOCKETS.

No portion of the lamp socket exposed to contact with outside objects must be allowed to come into electrical contact with either of the conductors.

CORD PENDANTS—Must be:

1. Made of conductors, each of which is composed of several strands insulated from the other conductor by a mechanical separator of carbonizable material, and both surrounded in damp places with a moisture-proof and a non-inflammable layer.

2. Protected by insulating bushings where the cord enters the socket.

3. So suspended that the entire weight of the socket and lamp will be borne by knots, above the point where the cord comes through the ceiling block or rosette, in order that the strain may be taken from the joints and binding screws. All sockets used for wire or cord pendants should have openings at least equal to one-quarter inch gas pipe size.

4. Allowed to sustain nothing heavier than a four-light cluster, and in such a case special provision should be made by an extra heavy cord or wire, as a mechanical reinforcement.

5. Equipped with keyless sockets as far as practicable, controlled by wall switches. In no case may a lamp giving more than fifty (50) candle power be placed in a key-socket on a flexible pendant.

CLASS D.—ALTERNATING SYSTEMS.

CONVERTERS OR TRANSFORMERS.

CONVERTERS—Must not:

1. Be placed inside of any building except the central station, unless as hereinafter provided.

2. Be placed in any but metallic or non-combustible cases.

3. Be attached to the outside walls of buildings, unless separated therefrom by substantial insulating supports.

4. Be placed in any other than a dry and convenient location (which can be secured from opening into the interior of the building, such as a vault) when an underground service is used.

5. Be placed without safety fuses at the junction between main and service conductors and safety fuses in the secondary circuits where they will not be affected by the heat of the converter.

PRIMARY CONDUCTORS.

In those cases where it may not be possible to exclude the transformers and primary wires entirely from the building, the following precautions must be strictly observed:

1. The transformer must be located at a point as near as possible to that at which the primary wires enter the building.

2. Between these points the conductors must be heavily insulated with a coating of moisture-proof material, and in addition, must be so covered and protected that mechanical injury to them or contact with them shall be practically impossible.

3. The primary conductors, if within a building, must be furnished with a double-pole switch, and also with an automatic double-pole cut-out where the wires enter the building, or where they leave the main line. on the pole or in the conduit. These switches should, if possible, be enclosed in secure and fireproof boxes outside the building.

4. The primary conductors, when inside a building, must be kept apart at least ten inches, and the same distance from all other conducting bodies.

SECONDARY CONDUCTORS.

The conductors from the secondary coil of the transformer to the lamps or other translating devices must be installed according to the rules for "inside wiring" for "Low Potential Systems."

CLASS E.—ELECTRIC RAILWAYS.

POWER STATIONS.

All rules pertaining to arc light wires and stations shall apply (so far as practicable) to street railway power stations and their conductors.

RAILWAY SYSTEMS WITH GROUND RETURN.

Electric railway systems in which the motor cars are driven by a current from a single wire, with ground or floor return circuit, are prohibited *except* as hereinafter provided:

1. When there is no liability of other conductors coming in contact with the trolley wire.

2. When the location of the generator is such that the ground circuit will not create a fire hazard to the property.

3. When an approved automatic circuit breaker or other device that will immediately cut off the current in case the trolley wires become grounded, is introduced in each circuit as it leaves the power station. This device must be mounted on a fireproof base and be in full view of the attendant.

TROLLEY WIRES.

TROLLEY WIRES—Must be:

1. No smaller than No. 0 B. & S., copper, or No. 4 B. & S., silicon bronze, and must readily stand the strain put upon them when in use.

2. Well insulated from their supports, and in case of the side or double-pole construction, the supports shall also be insulated from the poles immediately outside the trolley wire.

3. Capable of being disconnected at the power house, or of being divided into sections, so that in case of fire on the railway route, the current may be shut off from the particular section and not interfere with the work of the firemen in extinguishing the flames. This rule also applies to feeders.

4. Safely protected against contact with all other conductors.

CAR WIRING.

All wires in cars must be run out of reach of the passengers and shall be insulated with a waterproof insulation.

LIGHTING AND RAILWAY POWER WIRES.

Lighting and power wires must not be permitted in the same circuit with trolley wires with a ground return, except in street railway cars, car houses, and power stations. The same dynamo may be used for both purposes, provided the connection from the dynamo for each circuit shall be a double-pole switch so arranged that only one of the circuits can be in use at the same time.

CLASS F.—BATTERIES.

When current for light and power is taken from primary or secondary batteries, the same general regulations must be observed as apply to such wires fed from dynamo generators, developing the same difference of potential.

CLASS G.—MISCELLANEOUS.

1. The wiring in any building must test free from "grounds" before the current is turned on. This test may be made with a magneto that will ring through a resistance of 20,000 ohms, where currents of less than 250 volts are used.

2. No ground wires for lightning arresters may be attached to gas pipes within the building.

3. All conductors connecting with telephone, district messenger, burglar alarm, watch clock, electric time and other similar instruments must, if in any portion of their length they are liable to become crossed with circuits carrying currents for light or power, be provided near the point of entrance to the building with some protective device which will operate to shunt the instruments in case of a dangerous rise of potential, and will open the circuit and arrest an abnormal current flow. Any conductor normally forming an innocuous circuit may become a source of

fire hazard if crossed with another conductor through which it may become charged with a relatively high pressure.

(Signed)

A. J. DeCamp, Chairman; M. D. Law, Stephen E. Barton Wm. Brophy, T. Carpenter Smith.

Certain questions have come before the committee, which they considered of too great importance to be decided at this stage. Among these are the subjects of the grounding of the neutral wire in compensating or three-wire systems—the grounding, either permanently or through automatic cut-outs, of the secondary wires in transformer systems—the adoption of a uniform alloy for fusible cut-outs—and the adoption of better methods for testing circuits.

From the nature of the electrical business and the rapid advance it is making, there must, of necessity, questions continually arise which can only be decided by a later and larger experience, therefore the object of the Association would be best served by the appointment of a permanent committee to whom should be referred all such questions, which they shall consider and report upon at the next succeeding meeting of the Association.

Your committee, therefore, offer the following:

Resolved: That a committee of five be appointed by the President, to be a permanent committee on safe methods of construction and operation—any vacancies that may occur on the committee from time to time to be filled by the President.

(Signed) (Committee,)

Wm. McDevitt, T. Carpenter Smith, Wm. Brophy, M. D. Law.

LIST OF ATTENDANTS AT THE MONTREAL CONVENTION.

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FOURTEENTH CONVENTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION, MONTREAL, SEPT. 7-11, 1891.

THE Association began its Fourteenth Convention at the Windsor Hall, Montreal, Sept. 7, at 3 p. m.

PROF. BOVEY, as chairman of the Citizens' Committee, welcomed the Association, and introduced
MAYOR JAMES MCSHANE, who bade the delegates welcome also. He was followed in a similar strain by Sir Donald A Smith, Sir J. W. Dawson, principal of McGill University; Aldermen Clendenning and Cunningham, Mr. Justice Wurtele, ex-Mayor Beaugrand, Mr. Richard White.
PRESIDENT HUNTLEY then said:

Mr. Chairman, Ladies and Gentlemen:

For the first time in its history the National Electric Light Association meets on other than its native soil. Yet, even in so doing, it but adds new evidence to the feeling in the breast of every electrician that his art is foremost among the influences tending to promote human intercourse and break down the walls of separation. Coming, as do our members from every State in the Union and the Dominion of Canada and representative as they are of all the varied agencies and methods for the distribution of the electric light and power, it affords me the greatest pleasure to acknowledge in their name the fraternal welcome with which we have all been received, and the lavish hospitality that makes us at home in this noble Dominion and in its magnificent city of Montreal (applause).

From the fact that the invitation was so cordial, and that the reception has been so warm, I can but infer that the Association enjoys here an intelligent appreciation of its work, its object and its aims. Permit me to say, therefore, that the Association asks for itself, during the coming week, a kindly tolerance of its technical papers and discussions, hoping that the large exhibit of electrical apparatus of the latest and most perfected character may make amends for the somewhat abstruse nature of its proceedings. If the earnest and practical quality of our dealing with the great questions of electricity shall in anywise stimulate electrical work in Canada, and lead to the electrical utilization of its great water powers and coal beds in light, locomotion, power and heating, we trust it will be accepted as at least some slight acknowledgement of the manner in which we have been so generously greeted (applause).

UNITED STATES COUNSUL GENERAL KNAPP then said a few words in behalf of the United States.

JUDGE ARMSTRONG, of Camden, N. J., then made a very felicitous response on behalf of the Association, and he was supported by

MR. ERASTUS WIMAN, who while claiming for Canada a greater development than other countries in the telegraph and telephone, and a very healthy growth in electric lighting, invited the attention of his fellow Canadians to the possibilities of electric power especially in the domain of electric railway work, instancing the great Thomson-Houston road of the West End Co. in Boston as an example. He said that nothing had so appreciated the values real estate in America as the electric roads now started and running successfully in 400 towns and cities; and he wanted Canada to enjoy the advantages of the same methods. Certainly, Montreal, of all cities, would be greatly benefited by it.

PRESIDENT HUNTLEY then read the following address:

OPENING ADDRESS OF PRESIDENT HUNTLEY.

My predecessors in this chair have seen the Association advance in strength and worth, outliving trials and vicissitudes, to emerge on a wider, larger field of usefulness and opportunity. I do not believe that there is another industry in the world which has passed through such quick stages of evolution as ours, and become so soon established in popular favor and general prosperity. But we must not assume that because electric lighting has set its feet upon the rock, and laid its deep foundations, nothing more remains to be done save to pursue the policy and practice of the past. On the contrary, I deem it necessary to say here, that my own responsibilities, as a central station manager, compel me, as never before, to be watchful of the tendency of conditions and inventions in the art, so that I may, in any degree, profit from my own hard-won experience. If, as central station men, we are to secure adequate return on the investment committed to our care, it becomes us in every way to study closely all the ideas that will give higher efficiency of plant, and higher economy in operation. There was a time when some of us expected to grow rich out of abnormal prices, paid willingly for a novelty. To-day there is not one of us who does not know that his hopes of dividend lie wholly in the skill with which the best business ability and the soundest engineering are applied to the work in hand.

It is now pretty well recognized among intelligent station managers that the day has passed when they can limit themselves to one class of service or apparatus, to the exclusion of all others. To obtain the fullest measure of success, and the largest return from the capital invested, they must be ready to supply any demand made upon them, and, as a result, the successful station, even to-day, is gradually assuming a composite character. This compositeness is manifesting itself first in the variety of apparatus, as a result of the selection of the machines best adapted to a given class of work, and independent of any particular system. One cannot help seeing in this change from early practice, a step towards increased efficiency of station operation, as well as a good reactive effect upon the manufacturers of apparatus, who are thus all placed on a common basis of competition. But besides a compositeness in detail, signs are not wanting that no one method of distribution from a central station can, in the large majority of cases, be adequate to the demands that are made upon us, and that to meet them in a manner to insure a profitable business requires a flexibility and variety in methods of distribution, the full extent of which is to-day hardly recognized. To reach the full limit of its usefulness the central station should avail itself of methods which, I believe, will finally resolve themselves into what may be called the "Zone System" of distribution.

The idea embodied in the zone system can best be explained, perhaps, by taking a concrete, practical example, and for this purpose the present occasion makes the selection of the city of Montreal an interesting one. Setting aside for the moment the possibility, and even the probability, of the transmission of electrical energy to the city from the power obtained at the Lachine Rapids, we will assume a station erected at the water-front of the Harbor, as indicated on my diagram. It will, I believe, be granted that up to within a distance of one-third of a mile radius the three-wire low-tension direct-current system of distribution answers fully every requirement of simplicity and economy, and hence, if, with the station as a centre, we draw a circle having a radius of one-third of a mile, we shall have a "zone" supplied in the most economical manner for every class of light and power apparatus now familiar to us.

Coming to the districts beyond the first zone, we are necessarily obliged to have recourse to higher potentials for the feeders, and the selection of the proper potential is a matter of simple calculation. We may, for the sake of this argument, call it 500 volts. Continuing on in this way, in steps of 500 volts, successive zones, half a mile across, might extend in the aggregate to several miles without reaching the limit of [illegible] which have been found to be perfectly feasible in practi[illegible]

In the example no reference has been [illegible] of the current employed or to the method of local [illegible] Evidently we may readily resort to the alterna[illegible] employing converters to reduce or raise the potenti[illegible] rect current reduced from high to low by motor-dy[illegible] one is perfectly practicable. Perhaps some of [illegible] of electrical engineers will show us how to use [illegible] for both alternating and direct currents.

[illegible] system [illegible] per to record [illegible] ay to distribute [illegible], is by low-pres- [illegible] plan now generally in [illegible] of his own; or, in the direct system, a separate motor-dynamo. I need not here enlarge upon the train of reasoning which has led me to this conclusion, but I may remark that I am strengthened therein by my own experience in Buffalo, where we are now introducing gradually 200-light converters, and replacing the smaller ones heretofore employed. Nor do we propose to stop there, but expect to install converters of still higher capacity, distributing the current to a number of customers by low-pressure mains centering at the large converters. As addressing myself to practical men, I need not refer to the fact that it costs practically no more for labor, etc., to put up a 200-light converter than it does a 10-lighter, while the initial cost per light is less in the case of the larger converter. In these conclusions I am only recommending for large American areas what I believe is now recognized abroad by Ferranti and others, whose work, like our own, will eventually lead to the establishment of large converter sub-stations from which low-tension wires will supply the surrounding districts.

The allusion made to the motor-dynamo system for converting the direct current from high to low potential may to some appear nothing more than the citing of a possible method in view of the existence of the alternating system, well tried and ready at hand. But, without wishing in the least to detract from the merits of this system, which has probably done more to popularize electricity than any other, I cannot, as a practical man, conceal from myself the fact that, taking everything into consideration, the low-tension direct-current system of distribution is the most flexible within its area, and serves the greatest variety of purposes. I do not think that any one can successfully contradict the assertion that to-day no other system can, with equal efficiency, take care of arc and incandescent lamps, motors, large and small, storage batteries, electric heaters, etc.

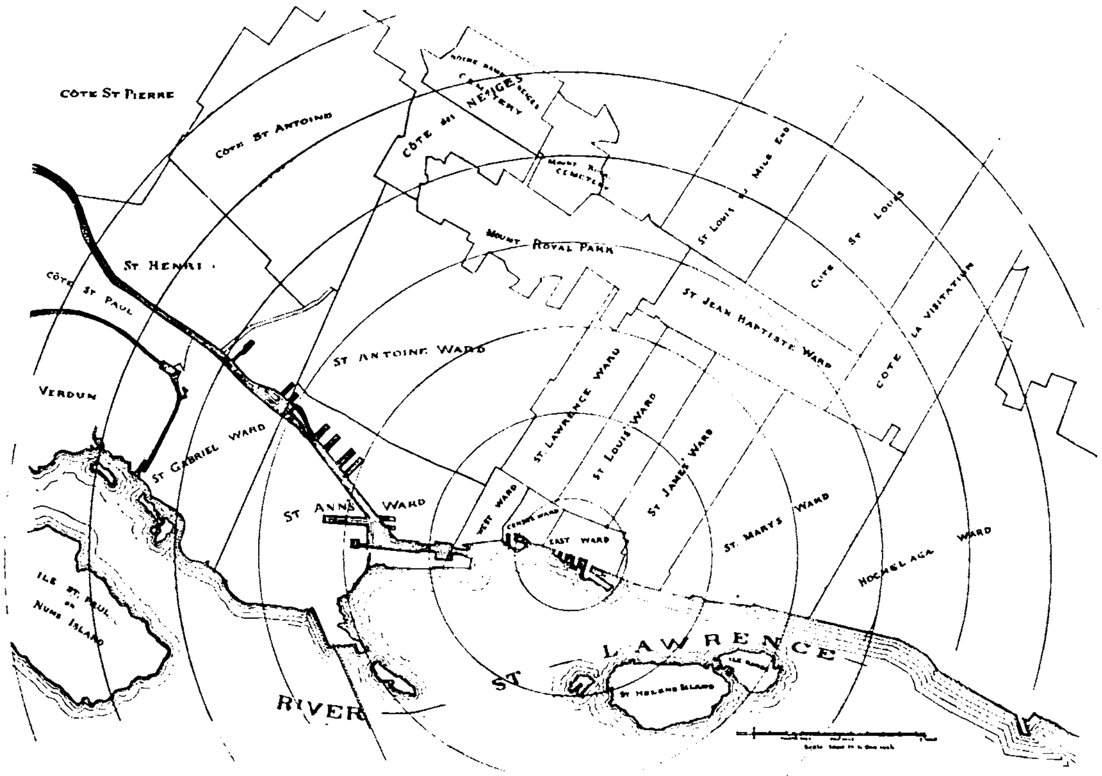
In making this statement, I desire to be understood as referring to the *present condition* of the art, the only condition which, as practical men, we ought to consider in matters of this kind; but I hope the time will soon come when the same can be said of the alternating system.

There are still o[illegible]thods which suggest themselves, by which the "zone" [illegible]ould be effectually carried out, but those indicated are [illegible] to demonstrate the idea I have endeavored to conv[illegible]

After the intell[illegible] manager has decided upon the nature of his appar[illegible] the initial capacity of his station, his most important co[illegible] is the allowance to be made for [illegible] growth. Lo[illegible]ome of you, and recall the mistakes [illegible] but which w[illegible] about by the enormously rapid [illegible] of the indu[illegible] not go outside of my own experi[illegible] such an [illegible] Less than two and a half years ago [illegible] in Buffa[illegible]tion considered far too large for [illegible] most ext[illegible] growth. Some of my colleagues shook their heads. Yet even to-day it is being worked to its fullest capacity, and provision will soon have to be made for more facilities.

What, then, may be asked, shall we determine upon as the unit time limit of growth for which provision should be made? Shall we build our stations sufficiently large to take care of the demands of five, or ten, or twenty years hence? This is a most serious question, and one to my mind as important as the selection of the proper station apparatus itself. I note the erection of several stations abroad, and some here, designed to supply the demands of 15 or 20 years hence. Without wishing in any way to detract from the laudable enterprise and faith exhibited by the promoters of these stations, a calm survey of the past, present, and probable future condition of the art leads me to believe that the setting of so long a time limit as 15 or 20 years is inadvisable. I need not remind you in detail of the changes in methods and apparatus which have been effected during the last five years, by which the efficiency and output of our stations has been increased; and if to this we add the fact that already new methods, such as those recently pointed out by Mr. Tesla, may at any time increase the present lamp capacity of our stations five and ten fold, I think we may be justified in placing five years as the limit of time, to make provisions beyond which may involve expenditures, the benefits of which may not be realized.

These are matters we are endeavoring to settle for ourselves. It is to our interest to settle them. So, too, with the underground question, but there we have gratuitous advice, assistance and abuse, to such an extent that less progress is made than in any other part of the work. We all want to put our wires underground where the number is so great as to make them unsightly or unwieldy, and not a few of us have been parties to experiments now written off to profit and loss. As soon as the time arrives when every house has its wiring as a matter of course, just as now it has its piping for water and gas, it will be a comparatively easy matter lay down comprehensive underground systems. But at the present time the customers for current are scattered, and not continuous. The man with enterprise enough to take electric light and power soon moves into a larger store. His successor does not want the service, but gropes along with kerosene, or spoils his goods with gas. Cutting out disused underground services is an added risk and expense, and ten lights could be installed on overhead circuits for ten dollars, where with underground the cost would be fifty. It follows that in any city, Buffalo, for example, we shall not make one underground connection where with overhead wires we should have made twenty. Now, are the public or are we the greatest losers? The public, I think. It is as unreasonable in most instances to demand underground wires as it is to expect every railroad to make every crossing above or below grade. But for our overhead wires, America would not be to-day the great



Pres. Huntley's "Zone System" of Electrical Distribution.

land that it is of electrical triumphs; and, while I hail with delight every advance in the solution of the underground problem, I hope long to gladden my eyes with the sight of a pole well set and a wire well strung.

Another stirring question of the hour is that of municipal ownership. Now, it has been taken for granted that electric light men are against this plan, tooth and nail. How absurd that notion is! Because we represent the latest development of invention and industry, we certainly do not forfeit our pride as citizens, nor lose our interest in the advance of social science. It would, in fact, be difficult to find a more progressive, well-known body of men in America to-day than they who have put their money and energies into electric lighting. They are neither crusted nor cranky, but when any movement has been started for the betterment of the communities in which they live, some of them have been at its head. Now, is it strange that such men should object to the confiscation of the properties they have built up and that are beginning to pay? Is it strange that they should ask for these new theories in social economy to be tried on something else first? Many of us have grave doubts as to the accuracy of the figures that are supposed to prove that municipal plants pay. Others of us have great objection to any taxation, the proceeds of which are to set the municipality up in a commercial business. Others, again, believe that the best results are reached in any industry when it is freest from political influences, and is left to the uplifting and perfecting impulses of individual enterprise.

I believe that the most conclusive answer we can make to the sophisticated arguments of an ill-disguised socialism, presenting itself in this muncipal ownership scheme, is to give the very best service possible at the lowest rates compatible with fair profit. Some of the prices we now obtain seem so low as to exclude any profit at all, especially when repairs and reconstruction are considered. But here again we may help ourselves out by native wit. Every company in the ranks of this Association ought to ascertain for itself at regular intervals just how it stands as an industry. A good deal of apparatus in use is decidedly inefficient. Overhaul it. If necessary, throw it out and put in better. Above all, adopt a good system of bookkeeeping. It has been a source of much gratification to me to see in the pages of one of the leading electrical journals, recently, a most valuable series of articles on central station management and finance by Mr. H. A. Foster. I trust that every electric light man will read those articles, if indeed he has not done so already. The subject is admirably treated from the practical standpoint, and it is impossible not to derive good from the many hints and suggestions; while the various forms and blanks shown may be adopted with much benefit. Electric light securities are to-day far from enjoying the esteem in financial circles that they deserve. This is due in a measure to speculative investment and to over-capitalization in the past, but is also attributable very often to the poor system of accounts employed, and I am glad to see the subject thus receiving attention. If we know what our current costs, we know what we can sell it for, and unless that information is obtainable from our office books, engineering will go for naught, and capital required for new work will stand aloof.

In conclusion, I would urge that the Association determine upon meeting only once a year. Even if it were not impossible to recover in six months from such overwhelming hospitality as we are now the recipients of, I believe that the time has gone by when half-yearly meetings were necessary. Once in twelve months is often enough for us to come together for the comparison of our experiences, and the report of further refinements in the detail of the industry. The mere fact that frequent reunions are no longer necessary is in itself a hopeful sign, for it tells of stable and settled conditions, and of activities that now require our presence at home pretty well the year around.

Various invitations were then read and accepted, and the meeting was adjourned till 10 a. m., Tuesday.

TUESDAY MORNING SESSION (SEPT. 8).

Upon the opening of the Convention, a report was read from Messrs. G. B. Shaw and E. A. Armstrong, recommending, as a committee on revision of the constitution, that no change be made, as the present form should be given a fair trial. Committee discharged.

The committee on relations between parent and sub-companies having made a formal report,

MR. E. R. WEEKS said—I think the time has come for some plain talk on this subject. You will remember that the early history of electric lighting was phenomenal in that the people were so ready to believe everything that was promised for the new industry, and so confident in its value as an investment. The wonderful achievements of Bell, Edison, and others in telegraphy and telephony did much to pave the way for the introduction of the electric light. Such was the attitude of the public mind that companies were readily organized for central station work, and the extravagant statement of parent companies as to the performance of machinery, of their apparatus and of their manufacture were received with a cordiality not very complimentary to the wits of investors. Manufacturers of apparatus claimed for it a high efficiency, in one case even as high as 105 per cent. Declarations were made, that with the exception of brushes and commutators, which might need renewing every two years, it was practically indestructible, nay, it was even held that it would improve with use, and they set their price so high on that, that these qualities seemed assured. They guaranteed to purchasers, first, high efficiency; second, patent protection, and third, exclusive rights in their respective territories. They assured investors that the new light could be produced cheaper than gas, and, in order to compete with gas, and increase the demand for the apparatus, they advised continual reductions in rates of service. Companies speedily organized in the larger cities, and capital smiled on electric light investments. It was soon found, however, that various so-called systems of electric lighting were extremely crowded, and the apparatus was so short-lived that investments must be increased to meet the demands for improvement and for renewals, for which the parent companies made little if any discounts. Still, so confident were the local companies of success during future years, and so blindly credulous in the good faith of manufacturers, that the additional capital flowed in, and the parent companies were enabled to enlarge their producing powers and to increase their dividends. In the course of time it began to appear that the second claim of the parent companies, in consideration of which local companies had paid such high prices, could not be maintained. Patent protection was not given. The pioneer enterprises saw their field invaded by apparatus employing the very devices for which they had paid so liberally upon the assurance that those devices were controlled by the granters. Meantime capital was beginning to discover that electric light investments were often bottomless abysses. The crude and imperfect apparatus, itself short-lived, necessitated constant renewals; its extreme delicacy necessitated frequent costly repairs, and the cut-throat competition, instigated and supported by rival manufacturers using practically the identical apparatus, affected public confidence. Most of the profitable fields had been occupied, and although the electric light had demonstrated its desirability and its superiority over gas, the rate of service was necessarily much higher, owing to the greater cost of plant, operation and maintenance. As the parent companies found themselves with immense producing powers, and without sufficient demand to employ them, the very powerful ones began to purchase the business and factories of the weaker, presumably to clear the field of competitors, and the temptation to violate their contracts with pioneer local companies proved to be strong. It was observed with a few of these systems that their purchasers had placed them in charge of their most experienced men, and after fortifying the weak points by the use of their own special devices, intending to sell this apparatus at greatly reduced prices in fields already fully occupied by their own apparatus, which had been bought at high prices by companies to whom they had promised protection of all kinds. What treachery could be more abominable for those who had borne the brunt of the new industry struggling for a foothold, who had literally enriched the parent companies by their own pleading, who had created the demand for apparatus that parent companies had to sell, and who, through their own experience, had shown inventors and manufacturers wherein their apparatus could be improved and cheapened. But worse treachery followed. The most outspoken enemy of the electric light has always been gas. The gas companies were heavy corporations who had fully occupied the field of lighting for many years, and had fattened upon the profits yielded by the industry of which they had a monopoly, and which required a plant comparatively simple in construction, easily and cheaply operated and maintained, and employing raw material, the residual products of which were made to yield a handsome revenue. When the electric light entered the field it labored under the enormous disadvantages of costly, complicated and imperfect apparatus, unknown operating expenses and depreciation, and no bye-products. Yet the gas interests, recognizing the new light as a formidable rival, fought it in every way available to a long established, powerful and wealthy monopoly. The parent electric companies were bitter in their denunciation of the methods employed by the gas interests in their efforts to prevent the establishment of the new industry, and until their revenues from local companies began to fail, assisted the latter in the struggle in every way which did not seriously affect their pockets. At the present time, Mr. President, the condition of affairs is changed. The gas interests are still opposed to the electric light. But as this has shown that it has come to stay, gas companies all over the world are preparing for a new effort. They will wage war with our weapons—with cheap apparatus furnished them by our parent companies. They will endeavor to so demoralize the field of electric lighting, that legitimate business cannot stand the strain. Parent companies are selling to the gas interests, and they have the effrontery in their advertisements to boast of their success, apparatus that employs the very devices whose exclusive control had been guaranteed to the interests that the new purchasers are straining every nerve to kill. And this is being done at a most critical period, when depreciation is becoming known at its full value, when, owing to the general depression, market values of service are at their lowest, and when there is a strong tendency on the part of municipalities to demand of the electric industries expensive, doubtful changes, and to curtail their privileges and reduce their rights. The manufacturing companies are indirectly and directly promoting this tendency, and are inciting municipalities to purchase plants, thus depriving local companies of that profitable service which they themselves have created. To the one hundred thousand stockholders in the local companies of America is chiefly due the establishment of the new industry. They have produced the sinews of war and by them the battle has been fought and won. From them parent companies have derived support which has made them what they are. For this veteran service and this timely support what return do parent companies make? Having possessed themselves of many millions of our hard-earned money, they are now violating their most sacred obligation and betraying us to the enemy. You, Mr. President, like Agricola Senex in the fable, have nurtured a viper in your bosom. You have created a Frankenstein monster who now turns his hand against you, and I warn you, central station men fo America, that, if you would save your millions, you must prepare to carry the war into 'Africa with respect both to the gas and to the parent companies. These two interests with their pronounced porcine proclivities in common must both be considered in this connection. The gas companies have, not without a certain assurance, fought well to concede to us the period of experimentation, believing that through the treachery of the parent companies they could easily step in and capture the business when its permanent value became known. After we have paid the score and quaff the froth, they, like the thirsty soul in Virgil, intend to seize the bowl and drain it to the dregs. But, Mr. President, if to them we seem vulnerable on account of the prices which we have paid for apparatus, let us not forget that they too have their undipped heel. Their plants also can be duplicated at much less than their original cost, and by improved processes their rates can generally be greatly reduced and still leave a large and a most attractive profit. For while gas is fast losing its place as the leading illuminant, it is certain to be the fuel of the future, and fuel will always be more generally and largely used than light. Fuel is everywhere a necessity, while light is largely a luxury. I therefore advise everyone interested in electrical central stations to investigate the gas business, subscribe for the gas journals, and let slip no opportunity to gather information regarding this great industry.

With regard to the parent companies, I will say that you central station men who have created these companies have the power to check their rapacity, and if need be to destroy it. Your interests are identical. You have a peculiar element of strength in that you do not seek to serve the same customers, and can therefore never be brought into conflict one with another. Your investments now aggregate upwards of one hundred millions and with stockholders among the best business men, the leading men of affairs in America. You have the power to inaugurate a movement and carry it forward which will be irresistible. Why should this army of producers with their one hundred millions of active and productive property, and their inexhaustible resources submit to the extortions and treacherous attacks of a few syndicates who are little more than brokers in material, whose *bona fide* investments aggregate twenty-five millions, and whose factories can be duplicated, yes, and greatly improved upon, for one half that sum? Let us enter into a compact whereby we will pledge ourselves to purchase apparatus only of those companies who will treat us fairly, and in case we cannot get such fair treatment, in case we are met by a combination, a trust or a pool on the other side, let us pledge our united support to a new manufacturing enterprise which will enter the field with this guaranteed business to rest upon, and Mr. President, if as a last resource, if the worst come to the worst, let us with our upwards of one hundred millions of investment call into a common fund from one to five, ten or even twenty per cent. on our investments and standardize our apparatus and do our own manufacturing. You, Mr. President, well know that there are already upwards of twelve millions pledged in writing to this movement. Your committee should push this work forward with all possible vigor, as it cannot fail to result in the greatest good to the greatest number. (Applause.)

JUDGE ARMSTRONG said that it resolved itself down to the principle that they would not deal with, or give business encouragement to, those who were thus against them. Mr. Wilmerding and Mr. Francisco both spoke in support of concerted action, the latter stating that he had had to furnish light at about one-third of the cost owing to this kind of guerilla warfare against him.

MR. T. C. SMITH urged that as controlling patents on nearly every one of the main essentials in arc lighting had run out, the remedy was in the hands of every local company to manufacture for itself. What the central station needed was information enabling it to use its old stuff already bought and paid for. He believed there was enough apparatus lying around central stations to do all the business for ten years to come.

MR. NICHOLLS remarked that, after all, they must admire an aggressive business policy, but in this instance he doubted the wisdom of the procedure of some of the manufacturing companies.

MR. WEEKS then offered the following resolution :

Resolved, That the Committee on Relations between parent and sub-companies be instructed to formulate a definite plan of procedure for the protection of the central station companies, and prepare the necessary articles of agreement and report the same to the Association in executive session at its next Convention.

This was adopted, as also a motion to print and distribute the whole discussion of the subject, at the earliest possible moment.

MR. H. W. SWETLAND, in the name of the Committee on Data, then presented a report upon the Comparison of Economy in the Generation of Power.

There being no report from the Committee on the World's Fair.

MR. J. A. HORNSBY, the secretary of the Electrical Department of the World's Fair, made the following remarks:

Gentlemen of the National Electric Light Association:

The World's Columbian Exposition was very much pleased a the action taken some time ago by your Association in th appointment of a Committee on World's Fair. That courtesy is responsible for my presence here to-day as the commissioned officer of the World's Fair, representing especially the electrical department. I had intended reading a paper on the subject of the World's Fair as a whole. You are, however, technical people, and I will try to explain to you practically, instead of reading a paper. The machinery building, which will be 500 feet long by 900 feet, is to be in every way a modern structure. It is impossible just at this time to tell how far the machinery department will go and where the electrical department will end. In the discussions of the classification committee of the World's Fair a year ago, the electrical department was given a group under the department of machinery and assigned to a corner of Machinery Hall. Its part was inconsiderable and very little was thought of it. The two learned gentlemen who assisted the commission to make the classification insisted that electricity was a branch of machinery and as such was entitled only to the consideration of being grouped with machinery. That has been changed; it is not so now. The electricity building is 700 feet long by 350 feet wide, having 240,000 square feet of floor space. It has a 100-foot gallery around the entire extent at an elvevation of 38 feet. The roof is 160 feet high, dome shape. It is in the Italian Renaissance archtecture, under contract to cost $650,000. That is to be purely for the electrical exhibits. The building for the service of the exposition with electricity occupies a larger scope than it did. Electric launches will be there. An electric intramural railway will traverse the entire length of the ground. The road will be three miles, or thereabouts, long. Electrically propelled elevators will be in all of the buildings. Everything that is done in the shape of power will be by electrical transmission (applause). This will be an expensive plant. The various companies engaged in the supply of power and light will be contracted with to build modern, model lighting and power stations of their own, after their own plans, to be approved only by the exposition management. This will be a 24,000 horse power plant—a large one, as you gentlemen, well know. The distribution will be in three directions. There will be a tunnel passing down through the Mines Building, the Transportation Building and its annex, the Horticultural Building and the Women's Building—these will be supplied from one source. Another tunnel will be built across, striking the coner of the Mines Building and passing through over to the Electricity Building, and thence through the Manufacturers' Building, the Government Building, the Fisheries Building, to the pier on which will be casinos, statues, fountains, etc. A short tunnel will be built also from this power-house, going first through Machinery Hall, down through the Agricultural Building, the Agricultural annex (the saw mills will be run entirely by electrically transmitted power) the Forestry Building and the Dairy. From this plant will be served 8,000 arc lamps, 85,000 incandescent lamps and 4,000 horse power for the operation of the machinery belonging to exhibitors.

There is a wooded island 30 acres in extent which it is contemplated to use for an aboriginal preserve, if you please—the Indians will probably be there. This island, the lagoons, canals—all of the grounds will be lighted by electricity. All of the buildings will be lighted by electricity. In our own building I have recently finished the plan. We will require in that building, and have arranged for, 800 horse power for the running of exhibits, aside from the operation of exhibits from the exhibitors' own plants which will be located here as well. In there we will have light proportioned, one 2,000 candle power lamp to 1,000 square feet of space. In addition to that, in the centre of the building we will have some spectacular effects, and in all of the corners; 700 arc lamps, I believe, are destined to that building.

So far as we are concerned ourselves, the electrical department has been divided, the "service" being absolutely separated from the "exhibition" department. All of the exhibition will be under the superintendence of the chief of the department of electricity. Everything electrical in the exposition will be on exhibition. But this other plant here will be purely a service plant, the exhibition feature to be a secondary consideration. It was contemplated originally to install a service plant proportioned to the good will of the electrical people—free lunch, as some one has been pleased to call it. The management of the exposition thought it would be possible on account of the general interest taken in the exposition to have the electrical people donate for the use of the exposition enough apparatus and enough talent to serve the purposes contemplated. By the hardest work and closest application of the electrical department we have made it appear advantageously, and certainly for the benefit of the electrical people, that that course would not be in accord with their wishes. Their interest would be dampened if such a procedure were to be inaugurated. Therefore we have been successful in having this plant installed purely as a business proposition, the idea being to demomstrate unequivocally and in practice the economy of an electrical service over that which was contemplated before—steam and gas. In that far we have been successful, and after the Columbian Exposition I think we will be able to demonstrate fully all that has been claimed for electricity on the score of economy, comfort, and luxury.

There is one other matter. I have been in correspondence for six months, or thereabouts, with electrical people in all parts of the world relative to the holding in Chicago in 1893 of an International Electrical Congress. I have arrived at a point in our correspondence and negotiation at which I can say the project is in the way of being successful beyond our highest hopes. We look for the presence in Chicago at that time of the ablest men in the greatest profession now in existence. The Europeans have promised to have their very highest authorities with us. The best of the electrical people of this country are heart and soul with us. The representatives of the societies in this country and in Europe have signified their intention of taking active hold of the matter of holding this International Electrical Congress. A good many of these congresses have been held heretofore, largely in Europe. A good deal of satisfactory work has been done in the settlement of standards, the unification of methods, the revision of nomenclature. Very little, however, of that work has been done in this country. The question has come up whether this should be done through and by the World's Columbian Exposition, or whether it should be done by the various societies. The question should be answered in the affirmative in both instances. It should be done by the societies. They have largely contributed already. It should be done under the auspices of the United States Government, which is the authority for holding the World's Columbian Exposition. As the representative of the electrical department, as its accredited commissioner to this Convention, I will say that the exposition management stands ready now, and at all times, to aid such a movement in any way. A provision has been made in the report of the presiding officer of the exposition management, which will be read before Congress next winter with a view to having the Government of the United States take official notice of the contemplated Electrical Congress. The management of the exposition have already acquiesced in the proposition to build a hall for the holding of this congress on the exhibition grounds. All of the adjuncts of debate will be present. No money will be spared by the management to make the congress in every way a successful one, and I do hope that at this meeting of this Association, strong, powerful, prominent, representative as it is—that some action should be inaugurated looking to the starting of the ball which shall roll to be a gigantic one. Something should be developed at this time that would give us a nucleus around which to work. In the course of time the other societies will take their part. The Electrical Engineers, I understand, have gone far already, and with the help of such societies as these, we have no question about farthering a proposition to hold an International Electrical Congress. (Applause).

MR. T. C. MARTIN—Mr. Hornsby in his remark has made reference to the work of the American Institute of Electrical Engineers in connection with this congress, and I think I may briefly state what has been done, and then if you will allow me, suggest that this Association act upon somewhat similar lines. Two and a half years ago, at least, at any rate before it was known that the World's Fair would go to Chicago, and when some of us still fondly hoped that it would not, the American Institute of Electrical Engineers, taking time by the forelock, appointed a committee to secure the holding of an Electrical Congress or conference in this country. A congress was then about to be held in France, at Paris, at the Exposition, and we sent delegates to that congress. Those delegates—some of our most prominent electrical engineers and inventors, among them being Mr. Edison, Prof. Elihu Thompson, and others of that rank—extended in the name of the Institute to the delegates to that Electrical Congress an invitation to attend such a congress in this country during the Columbian Fair year. The invitation was received and accepted. During the present year another congress of like nature is being held at Frankfort, in Germany. That congress in France was held under the auspices first, of the French Government and of the exposition authorities, and secondly, under the auspices of the French society. A similar procedure prevails at the present time in Germany with regard to the conference there, and it is being held under the auspices of the Government, and with the direct support and aid of the German society. Now I think that Mr. Hornsby has outlined to us just such a line of action for work in this country. It is proposed on the part of the Institute—and when I say that, I speak as secretary of the committee which has the work in hand—to work as far as lies in our power with the World's Fair authorities, and we think that, with the assistance and co-operation of such powerful bodies as this, the congress that is held in Chicago in 1893 will not only be the most memorable, but the most useful of all the congresses that have been held up to date. As a member of this Association I think it would be well in supporting Mr. Seely's motion to have a committee appointed that will work; that will commit this association unreservedly to the support of the World's Fair, and will aim to make the movement in Chicago, and the congress, a success. (Applause).

THE SECRETARY—The following is the motion of Mr. Seely: That the Committee on World's Fair be discharged, and that the Chair appoint a new committee.

The motion was seconded by Mr. Martin, and carried.

THE PRESIDENT—The Chair will appoint as such committee, Mr. B. Sunny, of Chicago; Mr. Coleman, of Milwaukee; Mr. Hart, of New Orleans; Mr. Royce, of Washington, and Mr. Price, of New York.

MR. PECK—As the report of the electrical section of the Committee on Data, I wish to present this form by which to record data concerning street lights.

JUDGE ARMSTRONG—I move that it be received and adopted.

MR. BURLEIGH—And that the Secretary of our Association refer it to the Census Department at Washington, with the request that they so arrange their statistics as to conform to that form. Agreed.

MR. WEEKS—My attention has been called to a clipping from one of the Kansas City papers which I find noticed editorially in THE ELECTRICAL ENGINEER of September 9th, regarding the price of street lighting in various cities of the country, and I take it that if data are to have any value whatever, they should be accurate, and I am very sorry to see that the data that are given by the Census Department in Census Bulletin No. 100, referred to in this article, are not accurate. For instance, the statement is quoted that in San Francisco the price is $440.67 for one arc lamp for one year, and in Denver $58.46. Those statements are made simply without any qualification whatever. I happened to be familiar with the facts in both cases, and I know that there is no foundation—absolutely no foundation for those statements, and I think that it is but just to our good friends Rollins, of Denver, and Roe, of San Francisco—than whom there are no fairer-minded and just men in the fraternity—that that statement be corrected. The facts are, that in San Francisco, where it should be remembered coal is $7.00 a ton, the highest price paid for any one lamp per year is $361.90, and that is a four thousand candle power lamp maintained at a point remote from the central station with a considerable mileage of circuit in order to reach that point. And instead of being so generous as one would infer brother Rollins has been in Denver to give them an arc lamp for $58.46; his good business sense has led him to do quite otherwise. The rate that he gets there is $160 within a certain radius and $216 outside, and for tower lighting—two very different propositions.

In this connection I want to call attention to the amendment that was suggested by the committee to the scheme proposed by Mr. Foote, that a very important factor in this whole matter one of the most important factors is the question of distribution. I have had occasion to look into this matter quite extensively of late, and I find that the distribution of municipal lights ranges all the way from eight and six-tenths lamps per mile of line, down to one lamp per mile of line. Any electrical engineer will at once appreciate the importance of this, and that element should always be included if a comparison of prices is made. Of course there are other elements that occur to almost every one—the system used, the watts consumed, the period of contract, the price of coal, whether it be water power or natural gas, but the mileage of circuit per lamp seems to have been generally overlooked. It is important in two ways—first, it determines the amount of investment. I find in the cities that I have looked up, that the investment per lamp in street systems ranges from $35.87 to $190.40. You can readily see that when it comes to operation it will be still more important, as not only has the resistance of the line to be overcome, but it has to be controlled and maintained, and your trimmers have to traverse all of this distance. I want to say that I think that Mr. Foote, in the schedule proposed, has covered the ground very thoroughly with the amendment suggested by the committee. I hope that he will find that it will be readily filled out by the central station men.

MR. FRANCISCO emphasized these remarks as to the present uncertainty of data alleged to be correct.

MR. FOOTE, as census agent, took the opportunity to ask that the information required in the census schedules be fully supplied, so that when they got the figures for tabulation, they would have something which was true.

JUDGE ARMSTRONG stated, from the Committee on Legislation, that it had no formal report to make. His own State of New Jersey had been comparatively free from antagonistic legislation.

MR. WILMERDING said that in Illinois there had been several bills introduced with a view of knocking out their interests, but none had gone through. He characterized these efforts as "sand-bagging."

MR. FRANCISCO was happy to report that in Vermont the legislature was not sitting this year.

THE PRESIDENT reported that little had been done in New York owing to the fact that the gentlemen who benefited by such measures were just at present fighting among themselves.

DR. BELL said it would be interesting to know just what the nigger in the fence was in all these "strikes."

MR. SCOTT—I just want to speak in relation to this matter that the gentlemen have spoken about, so far as to suggest that sometimes legislation is produced by the indiscretion of electric light companies themselves. In Pennsylvania, we have carefully watched the legislation and have tried to have everything avoided that was inimical to our interests, but there has been a bill passed at the last session which directly strikes at and affects their interests and which should not have been passed at all, and could not have been passed (for there was no money in it) but for the determined efforts upon the part of its promoters. That was a bill in relation to the cutting of trees. It is a most iniquitous piece of legislation. It provides that any person who has knowledge of the cutting or trimming of any tree along or upon any public highway, or the branches of trees upon private property, which protrude over the highway, by any telegraph, telephone or electric light company, and who shall lodge proper information, that thereupon the Court of Common Pleas shall appoint a jury of view, and that jury of view shall proceed to assess damages and costs upon such telegraph, telephone or electric light company. There was an influence brought to bear in favor of that bill which could not be overcome. Some of us took the trouble to contest it and found that the Suburban Electric Light Company of Philadelphia had asked the land association along their route for the privilege of cutting trees. They went to the secretary's office and asked for this privilege, and he said: "Yes, you can cut all that you want to"—meaning just to cover the right of way outside of their fence. But that company went to work and cut trees down that were inside of the fences. Any one traveling from Philadelphia to New York can see for over half a mile the fine trees lying right there on the road alongside the railroad track, along the State road from Philadelphia to Trenton. Well, it was a bad thing to do (laughter). And the land association, which is composed of politicians of Philadelphia, who can carry any measure through the legislature, decided at once that they would stop that business and so they put this bill through. So that it is not merely the aggrieved property owner, or anybody who may have any particular interest in the matter, but any tramp who comes along the road may lodge an information before the Court of Common Pleas, and then the damages have got to be assessed, even if it is only ten cents for that tramp. There is another matter of legislation that we have tried to accomplish in Pennsylvania. It is understood by every one who has had interest enough to look the matter up, that gas and water companies have an exclusive right—such an exclusive right that electric light companies cannot get. Now, there is no more reason why an electric light company starting in a small town, like our own town of Bristol, of eight thousand inhabitants, against a gas company which has been running since 1856, and has been paying eight or ten per cent. dividend right along—there is no reason why that gas company should have an exclusive franchise, whereas an electric light company, after having invested twenty or thirty thousand dollars in their plant, and have finally got the thing running, should be compelled to buck against any one who may choose to come in and make a competition. Those matters can be arranged in time, but of course it may take a long time, and it will require a great deal of trouble and effort on the part of somebody. We can do a thing of that kind in a better way than by the use of money. We can accomplish what we wish by argument. If you will just show the people who are interested in the corporation—your own stockholders, the men who have put their stamps down for the purpose of carrying on that business—that there is something that they have got to look out for, that just as soon as you begin to make eight or ten per cent. and to accumulate a surplus, the gas company or the water company in their own town, using the power which they can apply to that purpose, can run a pole line right along the side of us, and can take our customers right away by cutting our rates—that they can do this because they have an exclusive charter, whereas we cannot go in and manufacture gas or put water through the streets as they can do. I say that if you make your stockholders understand this, you may accomplish much. There are a great many of those questions that come up, and that ought to be looked after, not only by the Committee on Legislation, but it ought also to be the business of every man connected with a central station company, from officers to stockholders, to look out in this way for their pocketbooks (applause).

DR. BELL thought that something ought to be done with the "fake" electric light companies or organizations, chiefly composed of gas officials, which existed simply to keep a real, live operative company out of the field.

The committee was continued.

The Committee on Underground Work reported progress. It is now preparing an exhaustive report on the subject.

MR. T. C. SMITH then presented

THE REPORT OF THE COMMITTEE ON SAFE WIRING.

It was decided, on motion, to print the report at this Convention, and take it up as soon as practicable.

MR. WEEKS criticised the departure from the constitution in holding the meeting in September instead of during August.

MR. SEELY and the President explained that it had been done reluctantly, and of necessity, as the hotel accommodation could not be secured before.

The meeting then adjourned until 10 A. M. Wednesday.

THIRD SESSION, WEDNESDAY, SEPT. 9.

The Convention was called to order at 10:20 a. m.

THE PRESIDENT read a letter from the Canadian Pacific Railway Company offering the members of the Convention free telegraph privileges for social messages during your stay in Canada, over the Canadian Pacific Railway Company's telegraph; through Mr. A. B. Chandler, the president of the Postal Telegraph Company of New York, similar privileges over that telegraph system. An invitation was also read from Sir Donald A. Smith to the members of the Association and their friends to visit him.

The discussion of Mr. T. Carpenter Smith's paper on "The Distribution and Care of Alternating Currents"[1] was then taken up.

MR. LAW—I find that Mr. Smith has so thoroughly treated this subject of the distribution and care of alternating currents that he leaves but little to say. I most heartily endorse what he says of the short sighted policy of the majority of electric light managers in putting up cheap insulation; in other words, the principal point of success in alternating work may be stated in one word, "insulation," for on alternating wires a short circuit or ground means, as a rule, a burned-out armature. For I find that in most cases the dynamo man gets tired of renewing the fuses at the generator and will put in a 160 or 200 ampere fuse on a machine that is only adapted to carry 130 amperes. I find that the better plan is on a 130 ampere machine to put in a 135 to 140 ampere fuse and then change it often, not waiting for it to burn out, but change it and put in a new one. By doing this you keep the machine fused very close to its carrying capacity and the fuse will then go before the armature will become overheated. Not only should alternating lines be of good insulation, but the primary should in all cases be fused where they branch from the main lines to the converters. In other words, if you follow the insurance rules that have been presented to you for discussion, in primary construction the same as in secondary work, you will find, perhaps, an advantage in it. It is a very common practice to bring these branches directly from the mains to the converters without any protection whatever (other than the insulation on the wire) to prevent contact where one of these wires must cross the primary wires. I have seen a No. 8 wire burn off a No. 0 wire at the point where the primary loops cross the main lines, and a No. 0 wire, charged with a 1,000 volt alternating current, is not a nice thing to have down in the street, especially should the primary loops leading from the main lines to the converters be well insulated, for as a rule they are of small wire, because a large wire is not necessary; these wires are many times quite long, and being small, they soon get slack so that a good, stiff breeze will twist them together, and unless they are all well insulated, they will burn in two the first time that they are wet and they are not pleasant things to meet on a dark night. If proper fuses are placed where the branch joins the main line, it is not only a protection to your machines and converters, but to life also.

When taking charge of a very large station, a year and a half ago, I found a great many of, I am almost safe in saying all, the primary fuses were removed from the converters and No. 14 copper substituted, simply because they sometimes blew out. Now a properly placed fuse does not blow out unless there is a cause for it. There is the greatest danger in not having the primary wire fused before reaching the converter, although there is a remarkably small number of burn-outs in converters, yet when it does occur there is a danger of the primary wires becoming connected with the secondary and you have a 1,000 volt current at your lamps. All converters are so built that a contact between primary and secondary coils is almost impossible; but if by a short circuit in your primary, it receives a current of from 50 to 100 amperes, when it is only adapted to carry from one to five amperes, thus causing it to overheat to such an extent that it will burn any insulation which may be used. This is very liable to cross the primary and secondary wires and you have all the dangers of a high E. M. F. clear to your lamp socket. Properly fusing the primary wires will effectually prevent all this danger.

One weak point I find in alternating central station construction is the double-throw switches; they are never large enough to break the arc which they are sometimes required to do, for it has not only to break the usual load of from 50 to 75 amperes on

1. See THE ELECTRICAL ENGINEER, Feb. 25, 1891.

each circuit, but in case of a short circuit or ground it may reach three or four times that amount, and the fire and noise produced in a break of that kind is only realized by those who actually perform the operation. Likewise the fuses are not one-half large enough to break readily. These fuses are generally placed on the back of a wooden switchboard and are a great source of danger from fire. (Applause.)

MR. FRANCISCO remarked that in his experience one-half of the trouble met with in underground and overhead work had been due to the loose, miserable manner in which the overhead wires were put up. If the electric light companies themselves had thoroughly installed their system and run their wires in a proper manner, spending perhaps what they have for underground work, they would not have had one-half of the trouble they have at the present time. He was satisfied that if the electric light companies would even now—of course, in certain large cities there is no question in regard to what should be done, as the companies have got to go underground anyway, whether it be practical or not; but in a large proportion of the cities it would be found that if the companies would properly construct their lines and keep them so, they would have no difficulty with the city authorities. He said this after having interviewed a large number of the city officials of different places. Mr. Francisco was also decidedly in favor of operating for all kinds of service on the meter basis, where it is possible, as it permits of a thorough control of the business.

MR. LAW related a "trouble" with a meter which he traced down and found that the customer had actually pried up the cover and introduced a couple of spiders.

To avoid this action on the part of customers MR. FRANCISCO applied a small wire, so that when the customer pried open the meter he formed a short circuit, and he would never repeat the operation.

MR. AYER brought up the question as to the location of the cut-out on the fuse. Some manufacturers take the position that they should be separate and indepependent of the converter and left on the outside and should not be incorporated in the converter box, while with others it is the practice inside the box.

MR. T. CARPENTER SMITH, in reply, stated his experience had been that, as a rule, there is little trouble with the primary fuse in the converter except when it has to be replaced. He had for some time past left the secondary fuses out, and had always followed the practice of putting a cut-out immediately at the converter but on the outside of the converter, and found that he had a great deal of trouble with the secondary fuses from the fact that it is a heavy fuse and the contacts are not large enough. It is difficult to get contacts that will last three or four months without being corroded. He therefore put copper in those fuses and depended entirely on the cut-out which is immediately outside the converter. On the primary, in some cases, for large buildings, he puts cuts-outs on the pole and still keeps tbe fuses in the primary end. But he had had very little trouble with the primary fuse except in the case of short circuits, in which case the primary fuse always went. He never had any trouble with a short circuit from the blowing of the primary fuse, but believed others had had trouble with the primary terminals being so close together when the fuse blew that the lead vapor crosses and continues the arc. There were converters now made in which the primary fuses are put on a separate plug, and that plug is pushed in and can be taken out and the fuses replaced without touching any high tension wires or connections with the current on. That had another value, and that is, that the fuses, if required, could be soldered into the plug and spare plugs can be kept on band, while a lineman can go around once a week, or as often as is thought necessary, and by working the plugs keep the contacts clean.

MR. SMITH also pointed out the absolute necessity of maintaining the current on the wires without interruption even of a few seconds.

CAPT. BROPHY said that he frequently found wires in the primary and secondary side of the transformer instead of the fuse—not in one case but in hundreds of cases. The cause of this was the electrolytic action that takes place in the transformer which causes the fuses to give way. The transformer, when placed on a pole or on the outside of a building, is subject to the condensation of moisture on the inside, which is liable to lead to an accident to the lineman, who, to avoid the replacing of fuses, substitutes copper wire. For that reason he believed that the fuses should be placed in the transformer so that they are not subject to these cbanges. (Applause.)

MR. SCOTT remarked that there were troubles in converter fuses even when they were carefully watched all the time. About two years ago he had one converter that was persistently blowing its fuse. On examination, the base under the screw-head of the fuse connection showed a mark indicating that the fuse had melted there. The screw had become loose eitber by the swaying of the pole or the magnetic vibration of the converter and the screw had formed an arc which had melted the fuse. The brass had become red hot and the switchboard below it was completely charred for about half an inch behind it, so that the screw and its base were ready to fall through. After that he made his linemen go every thirty days and examine the fuses.

MR. SCOTT traced much of the trouble from lightning in small converters to the lineman's using a ten ampere fuse where a five ampere was required. The lightning thus passed through the fuse and burnt out the converters. Such troubles with the coil are generally six inches or a foot from the beginning of the coil, and he had never found an instance where the lightning had traversed the complete circuit. By just taking off the tape and paper the fault can be taken out and the converter will work just as well. But by sending a man around at least once a month to tighten up the screws under the fuses or to replace those that show any oxidation they can be kept in good order.

Regarding the meter question, MR. BLAXTER had adopted the method of demanding a guaranteed usage, and if the actual usage is under that guarantee they charge it according to that guarantee; if the usage is over that amount they charge it in the same way.

MR. T. CARPENTER SMITH stated that if the customer were impressed with the fact that he had to pay for the leakage on the large converters he would not install more lamps or converter capacity than he actually needed, and he cited an instance where a house wired up for 127 lamps with three 40-light converters, rarely had more than 10 lamps, and for a few hours only, so that finally two converters were taken out.

MR. REDMAN then read his paper on "Central Stations Operated by Water Power"[1] and introduced it by calling the attention of the members to the prices in Rochester, as given by him. They varied undoubtedly with the prices in some other cities, but it had to be born in mind that water power was used entirely. It had only been necessary during the past year to shovel coal for half a day, and that necessity was occasioned by the cleaning out of the race-way. Another thing that he called particular attention to was the development of the motor service. They had two motor services; with very few exceptions the motors are placed in dwellings or in small shops built in the rear of dwellings. Heretofore the small manufacturers resident had done business in the centre of the city, and on the fifth or sixth floors of buildings, but they now do their manufacturing at home, either in their dwellings or in small shops. As a boss tailor remarked, when he did his work down in the city, he only worked himself, but now, said he, "Mein frau and all the children work."

JUDGE ARMSTRONG drew attention to the fact that in making comparison of prices charged for lighting and power, account ought to be taken of the fact that in Rochester water power was used, a fact which city authorities are apt to overlook.

MR. REDMAN stated that where a motor is used for ventilating purposes they get $120 per annum, for constant service. No meter is used. He also referred to the heavy consumption of power by planers in machine shops, which was also confirmed by Mr. Francisco.

MR. FRANCISCO stated that if a consumer has a meter on, the charge is 25 cents per thousand watts, in Rutland Vt. They charged the same rate for light and power—25 cents per thousand watt hours. He also referred to an instance in which a customer made a contract in order to avoid the meter, but after a run it was shown that if he had paid by meter his bill would have been one-third of that paid under the contract.

MR. WILMERDING stated that if they could get at the rate of 25 cents per thousand watt hours they should prefer the meter, but he bad found the meter system unsatisfactory because the character of the service varies so much. Their charge for elevator service is from $5 per montb to $15. That is on the basis of ten cents per thousand watt hours. On their contract prices they make three rates: A rate for continuous power, a rate for intermittent power, and a rate for elevator service. For the elevator service they charge $5 per month per horse power, or $60 per year for any kind of elevator service. But he had never found that any of those elevators when run on the meter showed more than one-third of what the contract price would give. He had also found that customers are more surprised than he was at the small price that they have to pay for the service. For that reason he had concluded recently that he would not furnish any elevator service on the meter. (Laughter.) His coal cost $2.65 per ton, but they are using compound condensing engines, and their indicated coal consumption is not more than two pounds per horse power per hour.

MR. AYER: There has been nothing said here with reference to constant current rates and it may perhaps be of some value to some of us to know what the charges are in St. Louis. We are running in excess of two hundred constant current motors on arc circuits, and we make a charge of $10.50 for a single horse power for ten hours' service, regardless of the character of the service. Wherever we happen to have a variable load, we indicate the load on those motors, and we insist on their making a contract based on the maximum load. If we find them bringing in additional machines later, our motor inspector is very apt to get track of the fact, and we soon know just what they are doing. We find no

1. See page 300, this issue.

difficulty in making satisfactory arrangements on that basis. We find that on constant current motors the price has been satisfactory, and we have had no difficulty in making our contracts on motors at $10.50 per month per horse power. For three horse power and upwards we make the rate $8.50.

MR. WILMERDING did not want to be understood as saying that he made a $5 per month rate straight through, but that was on elevator service. Their lowest contract price for the intermittent service is $6.25, and the lowest price on constant power is $9 per month.

MR. T. CARPENTER SMITH stated that there was one advantage that a constant current motor had over a constant potential motor, and that was, that it would slow down if it was overloaded.

MR. H. WARD LEONARD remarked that the cost of water power, although it is apparently cheaper than steam, is frequently higher than it would have been for a first-class steam plant. He thought, further, that water power is really not sufficiently constant to entirely eliminate the steam plant. With the exception of a few plants where the water power is peculiarly favorable, the water power has to be assisted by a steam plant, and the ultimate expense is frequently higher than it would have been than if they had entirely disregarded the water power and built the steam plant at the best possible location. In his own experience he finds that the best use to make of water power is not that of operating a full load, but of taking care of that portion of the load which is quite light, and which operates between, say, 11 o'clock at night and dawn of the next day, for the load is fairly constant during those hours, and the economy of the water power is then more marked because it enables the services of an engineer to be dispensed with. The use of the water power had proved to be very economical in certain places where a not very reliable water power existed, but where perhaps fifty or one hundred horse power could be obtained at almost any period of the year, and which would answer to carry a light load during certain hours of the day and late at night.

MR. T. CARPENTER SMITH stated that the question of the relative cost of steam power and water power had been very fully considered in some papers which were read before the American Society of Mechanical Engineers, and notably in a paper read last year by Mr. Manning, of the Amoskeag Mills, at Manchester. The latter states that his experience has led him to the conclusion that, all things considered, steam will, under almost any conditions, if properly handled, be produced as cheaply as water power. Mr. Smith thought that in most central light stations the best use to make of the water power was to use it in condensing. Steam has an enormous advantage over water power in that with steam one can state almost to a certainty just what one's power will cost. If a steam engine has really to be installed anyhow as a relay to the water power, one might as well run with steam all the time, for one has got to keep the engineer there, and fires ready for lighting. And further, a steam engine possesses the ability to be driven beyond its rated capacity, whereas the water wheel is absolutely limited to the power contained in the head. Another paper, which was read some years ago by Mr. Lewis F. Lyne, on the use of headlight oil for keeping boilers clean, was also worthy the attention of the members. He had tried that oil, and had such success with it that he had used it ever since.

MR. H. WARD LEONARD then read a paper entitled "A Central Station Combining the Advantages of both the Continuous and Alternating Current Systems."[1]

In the discussion which followed,

MR. T. CARPENTER SMITH took issue with Mr. Leonard on his statement that the alternating system suffers by comparison with the three-wire system, "for its efficiency is much lower, its reliability is less due to the fact that its machines are not practically operated in multiple arc, its safety is necessarily less due to the existence of the high primary pressure, and its current is not adaptable to commercial use for motors, charging storage batteries, electro-deposition, and so forth." As to its efficiency, the converter system, as at present installed, may be lower than that of the three-wire system. But with regard to the satisfaction of the public, he thought that the efficiency of the alternating system was considerably higher, and he instanced a case of customers lost by irregularity in regulation of the three-wire system. Mr. Leonard had said that "its (the alternating system's) reliability is less, due to the fact that its machines are not practically operated in multiple arc." He did not think that that amounted to anything, and for this reason: that, while the machines are not generally operated in multiple arc, still they can be, and if there were any necessity for it they would be so operated. He preferred not to do it, because he thought that in case of accident to any one machine there is far less danger of accident to others. Another advantage and one in which safety is also concerned lies in the fact that the alternating system has its road divided up into small units. That is to say, no matter how badly the wiring may have been done in any one building it does not affect any other building, and one customer cannot threaten the safety of every other customer of that station by having his apparatus or the wiring in bad condition. A very serious question which was brought before the Committee on Safe Wiring is one that we have got to face before very long and to consider seriously, and that is the grounding of the neutral wire. There have been several arguments brought forward why this should be allowed. It practically came down to this, that the insurance agents and inspectors have preferred to ground the neutral wire, and practically make a return to the one-wire system of installing electric lights, to avoid the much greater danger of the 220 volt arc between outside wires, and the consequent damage in buildings where combination fixtures are used. He did not know whether it was not a good thing to go back to the one-wire system of wiring. If the grounding of the neutral wire is permitted they must also permit the grounding of the transformer. He denied the statement that the safety of the alternating current is necessarily less, due to the existence of the high primary pressure. Personally, he had never known of a case of contact between the primary and secondary coils of the converter. He knew that such have occurred, but he did not think that there had ever been one worth considering when we considered the enormous number of converters that have been put into service. The statement as to the alternating current not being adaptable to commercial use for motors so far would seem to be proved; but four years ago that same argument was brought forward—that the current could never be used for meters. He therefore thought that in a few years we shall see the motor in the same way. He thought that when one sums up the disadvantages of the alternating system it could be brought practically down to one, and that is poor efficiency on low loads. To meet that a system must be devised which will have all the advantages of the alternating system, and which will have an efficiency practically the same at high load as at low load. At high load he believed that the efficiency of the advanced transformer system was as nearly perfect as we are likely to get it.

MR. LEONARD, in reply, stated that Mr. Smith seemed to have made the error of assuming that he (Mr. Leonard) was appearing in the role of an advocate of the three-wire system. If such an impression existed he wished to correct it as promptly as possible. His remarks with reference to the three-wire systems and the alternating were such, he thought, that they would be admitted by almost every one to-day. He presumed that any one familiar with the facts would admit that the average efficiency of the three-wire system was higher, that it was conspicuously higher at light loads, and in speaking of the possibilities and advantages of the system which he had proposed he was only giving consideration to the existing conditions of to-day. Regarding the placing of machines in multiple one would almost nowhere find to-day an isolated plant where there are a large number of machines supplying a constant potential distribution, in which each machine is supplying a separate circuit. The possibilities of regulating and the economies are so much higher when machines are in multiple arc that, entirely outside of any consideration of central station supply or of the three-wire system, it seems as though the result of experience has been that where machines can be operated perfectly, simply and reliably with multiple arc it is better to do so. With reference to the question of grounding the neutral wire, Mr. Leonard agreed thoroughly with Mr. Smith that the grounding of the neutral wire is extremely bad practice, and that there is no argument for grounding the neutral except, perhaps, that of laziness. As to high pressure primary, the paper which he had read, of course, bore evidence in itself that he was a thorough believer in the necessity of high pressure primaries for reaching any great distance, and there certainly appeared to be an advantage in having those high pressure wires as few in number as possible. And instead of having a complete network through the city of high pressure wires, if we can by any means obtain a few of the high pressure wires to centres there would be less liability to any trouble due to the existence of high pressures. All of his remarks had been on the basis of the three-wire systems merely because of the saving in the cost of conductors which is attained thereby. Were we able to have a two hundred volt lamp instead 110 volts it would be of course infinitely preferable to have the two-wire system and use a 200 volt lamp than to have three wires for a lamp of 110 volts on each side, and furthermore the cost would be reduced even beyond that of the three-wire system. As to the sub-station method of operating on the outskirts of the town, that was unquestionably, when the alternating current motor is at hand, a very desirable way of operating. And yet it seemed that even there, until we have our two hundred volt lamp, it will be extremely advantageous to use for distribution something which will enable us to reduce the cost of our conductors on the consumers' premises to a point far below that with 50 volt lamps.

MR. SMITH stated that he had apparently made it clear that the 200-volt direct current in the building was what the insurance people are afraid of now, and that consequently we must abandon that pressure in any new system which is to be an improvement upon that. The use of an alternating current of 2.0 volts he did not believe would have that disadvantage, and in that case Mr. Leonard's plan would be all right.

MR. LEONARD, referring to the method of sub-stations as adopted by Mr. Ferranti mentioned by Mr. Smith, remarked that

1. See page 299, this issue.

Mr. Smith had not yet pointed out how he gets rid of the losses that will occur upon the final converters. He had put an intermediate set of converters in, and had taken means to take out converters as the load diminished, but his final converters in his distribution throughout the city were still connected, and were the same as we had before.

MR. SMITH replied that he would use the same plan as Mr. Leonard proposed in his system. He would have them grouped and switched in and out by the operator, just as he did in the sub-stations. He was only comparing one system as against the other. He still held to his proposition that multiple arcing was not used because it is a great advantage, but to allow of two machines being connected together. It is a good thing simply because in an isolated plant the conditions are different from what they are in a central station.

DR. LOUIS BELL doubted the advisability of constructing very large dynamos. With three or four smaller machines one may be able to crowd on a load and thus keep going. He had heard grave doubts suggested by those who know Mr. Ferranti personally as to whether he would ever complete his large machines. There was such a thing as getting an alternating current so big that you cannot handle it efficiently, and he thought that those units of Ferranti come very near that.

MR. SMITH, while not contending for 220 volts of alternating current in dwellings, desired only to point to the fact that as compared one with the other, if 220 volts of direct had not been found dangerous or objectionable, the 220 volts of alternating would not be found so.

MR. ORFORD stated that in Bridgeport he had been running the three-wire system, and had 3,000 lights in operation, on the direct plan, but he knew nothing of the danger refered to by Mr. Smith. He was also able to regulate the system perfectly and to throw machines in or out with no visible effect on the lamps in circuit. He had, on inquiry, decided not to install the alternating system.

CAPTAIN BROPHY said that, having to deal with people who use both systems, he did not wish, under any circumstances, to take sides in this discussion. He had probably had as much experience in watching the good and bad points of both systems as any one, owing to his position. They both had their good qualities. Regarding the matter of fuses, he had studiously insisted on increasing the size of fuses. The system of using a certain sized fuse for a given number of lamps had caused a great deal of trouble and annoyance. As a rule, in the central stations the fuses are altogether too small; they should never be below the safe carrying capacity of the wire, and in 95 cases out of a 100 they are, except, perhaps, in his own territory, where he had insisted on their being increased. He believed that if high potential or dangerous currents were used people should be told they are so. The losses from fire by the introduction of the electric light system had been too insignificant to take notice of. It was true that it is said that one of the largest fires in Boston for years was caused by the electric light. There were certain officials all through the country to-day, some of whom are more ornamental than useful, whose duty it sometimes is to determine the cause of a fire and they very often know very little about it. In years gone by the standard cause of a fire, when no other cause could be assigned, was matches, rats, acts of Providence, etc. Now it is electric light wires. He trusted that all would see that their wires were installed as carefully in the future as they had been in the past, and indeed improve on them. (Applause).

MR. BURLEIGH read his paper on "Central Station Accounts."[1]

MR. BURLEIGH said he was aware of the many difficulties that stood in the way of a uniform classification of accounts. To change the present systems would be embarrassing to many, but great good would follow a uniform classification. It was not necessary that all should keep their accounts exactly alike, but that they should agree on certain headings for expense charges, and what items are to go to those expense headings; so that when one hears his neighbor say that his arc light cost him so many cents per arc light hour one would know exactly what that includes.

MR. NICHOLLS drew attention to two points which he had adopted in his practice and which he finds of incalculable value. He had two private abstract books bound, with a lock and key on them, so that while they are kept in the regular vault they are not accessible. In the first book he has the charter under which he operates. He has his agreement with the city, the franchise, etc., copied in this book; also the different agreements with the companies with which he does business. In addition to having all those put down in this book he has them indexed and cross-indexed. If he has to refer to any particular clause or agreement as to powers of any kind he can, by looking at this index, find it at very short notice. He reads over these agreements periodically, because there may be a clause in an agreement that has been pigeon-holed which appears of no earthly use to one to-day, but a year from now it may be found to give you certain advantages, or under that agreement certain rights accrue which have been forgotten and which one may wishimmediatley to take advantage of.

1. See p. 302, this issue.

In the second book Mr. Nicholls keeps a monthly abstract of earnings and expenses. This he brings right up to the end of the month, and insists on having it before or not later than the 12th or 15th of the month following. In addition to having that copied out into his private abstract book, he has the cost of power as compared with the variable expense of the station made up. The power is estimated at the engine, the bus bar and at the service, allowing for the average drop. He also has the cost of his total power turned out compared with his total earnings. Thus he can tell what it has cost to produce power at the engine, at the bus bar and at the service for every month since he has been in operation, and consequently he is in a position to know exactly what he is doing.

MR. FRANCISCO, referring to a paragraph in Mr. Burleigh's paper, inquired how one could know how much power he is furnishing for arc lights where both are furnished from the same circuit, and where lights were being turned off and on.

MR. BURLEIGH, in reply, stated that that would have to be determined approximately.

MR. NICHOLLS added that he took ampere readings every fifteen minutes and recorded them in a book kept for that purpose. He also indicated the engines frequently.

MR. SCOTT—The principle of bookkeeping is like a tree branching out in every direction. Every one of those branches tends to the central trunk. The ledger is the reservoir of all accounts, and the only true way of keeping books is by a ledger, which ought to contain all the accounts. He employed a series of vouchers for construction, operating, merchandise, etc. accounts. A simple blotter would then do for a journal. On the cash book he subdivided by alloting 100 pages to construction, 100 pages to merchandise and 100 pages to operating. The journal entries show:

Cash, Dr., To Sundries:
By Capital Account.
By Merchandise.
By Lamp Rentals.

Sundries, Dr., To Cash:
To Construction Vouchers.
To Operating Vouchers.
To Merchandise Vouchers.

The posting is direct from those vouchers which have the signature of the foreman who receipted for the bill at the bottom and also the signature of the president and secretary, showing that the voucher has been passed at a regular meeting of the board and is signed by the secretary and treasurer. Then the ledger accounts will show capital, surplus, profit and loss, real estate, station, engine No. 1, 2, 3, 4, boiler No. 1, 2, etc., engine connections, converters, meters, poles, wire, labor and expenses on line, pins and insulators, etc., merchandise, coal, oil and waste, insurance, taxes, operating expenses. Then in addition he has a lamp record which is taken from the blotter in the storeroom. Each customer's account shows a debit for the lamp issued with a credit for the lamp returned. Those lamps are all numbered consecutively and the numbers are entered on the record. The numbers are retained in that record. At the end of a year, or six months, or three months, the lamp record is examined and the renewals are charged in the proper account in the ledger. The board of directors have submitted to them monthly a balance sheet from the ledger, and the board, as a committee of the whole, audit these accounts before each meeting of the stockholders and strike off for depreciation whatever they think is necessary; thus, poles at 28 per cent.; tools from 25 to 50 per cent., etc. The whole shows just exactly what it has cost to run the station, to supply the number of lamps that is shown by the lamp record. For instance, last year he produced 1,919,000 amperes of current at a cost of 1,110,000 net pounds of coal.

THE PRESIDENT described in brief the system of bookkeeping employed in connection with his company in Buffalo. This had been modeled after the methods in use in the gas interests of the Standard Oil Co., and had given good results. He had already furnished several members with the blank forms employed by him and referred also to the articles of Mr. H. A. Foster on "Station Management and Finance," which appeared recently in THE ELECTRICAL ENGINEER, as affording an excellent basis for station accounts.

The Convention adjourned until the following day.

FOURTH SESSION. THURSDAY, SEPTEMBER 10.

The Association met at 10 A.M. THE PRESIDENT read an invitation from the Business Men's Association of Norfolk, Virginia, to hold the next meeting of the Association in that city. Also an invitation from Robert M. May, Mayor of Augusta, Ga., and from the Cotton Exchange, Exposition Company, and the Commercial Club, of Augusta, to hold the next meeting of the Association in that city. On motion, the invitations were received and referred to the Executive Committee.

CAPT. EUGENE GRIFFIN then read a paper, entitled "Three Years' Development of Electric Railways."[1]

1. See p. 310, this issue.

In the discussion which followed MR. W. J. HAMMER referred to the fact that Capt. Griffin had not mentioned some of the experiments of Dr. Siemens, whose railroad is still running in Berlin, and which dated beyond any that Capt. Griffin had referred to, and he also mentioned several other experiments, among them those at Menlo Park in 1880 and 1881.

CAPT. GRIFFIN replied that he did not intend that the list should be taken as complete, but had confined it simply to the United States, and to electric cars which had been actually operated on existing roads.

JUDGE ARMSTRONG stated that so far as the experience of the railroad company which he represented was concerned, the very fact of operating the lines by electricity had brought them large additional travel. Not because they make better time (because they run exactly on the same schedules as they did with horses), not that their cars were any more comfortable, but seemingly from the very fact that there is a motive power there which requires the expenditure of no life energy whatever. Judge Armstrong did not agree with Capt. Griffin that it will pay to put down an electric road where a horse road would not pay, because one could surely, he thought, operate a horse railroad at less expense by running fewer cars than one could possibly operate an electric road where the steam plant and power for producing electricity has to be kept ready all the time. If the road is operated on a fifteen minutes or half hour schedule on street cars, that is not necessary. But under given conditions, where the travel can reasonably be kept at a fair schedule, Capt. Griffin might be, and perhaps was, right. His experience was that it paid only because they carried so many more people than they did when they were operating by horses.

DR. BELL stated that as the result of inquiries made by him he had found that there had been great increase in traffic, varying from 20 per cent. to 300 per cent., following the change from horses to electricity, whereas the actual expenses (although greater with electricity than with horses) were much less in proportion to the traffic with electricity than with horses, and that furthermore very frequently a real decrease in the running expenses was observed. He thought that there were certain classes of roads which are operated every day by electricity that never could be profitably operated by horses, that is, roads on grades which are far too severe for successful regular operation with horses, and which at the same time run through regions too sparsely settled to permit of surmounting grades by cables.

THE PRESIDENT then read the following despatch :

Mr. Allen S. Foote :

All investigations in charge of expert special agents have been postposed until after the meeting of Congress. All agents have been dropped, including yourself. Letter by mail.

Signed, ROBERT P. PORTER.

The reading of this despatch called forth a storm of indignation, and Dr. A. F. Mason offered the following resolution :

Whereas, the Hon. Robert P. Porter, Superintendent of the Eleventh Census, has authorized the collection of the statistics of the electrical industries and has appointed Mr. Allen R. Foote special expert agent for that purpose; and

Whereas, Mr. Foote has prepared schedules for the collection of such statistics covering nearly every known practical use of electrical energy; and

Whereas, these schedules provide for information of great public value that is imperatively demanded for the intelligent discussion and settlement of questions of grave public importance; and

Whereas, this Association is advised that the work undertaken is in danger of being delayed, if not altogether abandoned, by reason of insufficient appropriation, thus utterly wasting the $12,000 or $15,000 already expended, and what is of far more serious moment, depriving the people of the benefits derivable from a report that there is reason to believe would be a thorough and reliable authority on the subjects of which it treats:

Therefore be it resolved,

1. That this Association respectfully request the Hon. Robert P. Porter Superintendent of Census, or, if he is not sufficiently empowered, the Hon. John W. Noble, Secretary of the Interior, to provide for the carrying to the earliest possible completion of the work so well begun.

2. That immediately upon the convening of the 52d Congress, the Executive Committee of this Association be directed to secure the reintroduction of Senate Bill No. 4,329, of the 51st Congress, appropriating $50,000 for the special work under Mr. Foote's direction and to use all proper means to secure its passage at the earliest possible date.

3. That this Association hereby expresses its approval and high appreciation of the work Mr. Foote has done in his official capacity as special agent of the Eleventh Census for the Collection of the Statistics of the Electrical Industries and its belief that the reports he may prepare, if enabled fully to carry out his plans therefor as shown by the schedules submitted by him for examination, will have a value equal to that of the most valuable reports ever issued by the United States Government.

4. That the President and Secretary of the Association be directed to at once forward a certified copy of these preambles and resolutions to the Hon. John W. Noble, Secretary of the Interior; the Hon. Robert P. Porter, Superintendent of Census, and Allen R. Foote, special agent for the Eleventh Census, at Washington, D. C.

DR. MASON concluded by stating that he had carefully gone over the census schedule prepared by Mr. Foote, and had found them to be by far the most complete of their kind which had ever come under his notice.

The resolutions were unanimously adopted.

DR. MASON then moved "That a committee of five members of the National Electric Light Association be appointed who shall carry to Washington the preamble and resolutions just adopted, present the same to the Hon. the Superintendent of Census, the Hon. the Secretary of the Interior, and, if desirable, to the President of the United States, and urge the necessity of the continuance without a day's delay of the work of Special Agent Foote." The resolution was unanimously adopted.

DR. MASON then offered the following resolution :

Resolved, That the Association request the co-operation of other electrical associations and societies, also all associations or societies directly or indirectly interested in the subject, in measures to secure the carrying to completion of the census work commenced by Special Agent Allen R. Foote for the collection o statistics of the electrical industries.

The resolution was unanimously adopted.

THE CONVENTION then took up the Report of the Committee on Safe Wiring Rules, and Dr. Mason offered the following resolution :

Resolved, That a committee of five be appointed by the President, to be a permanent Committee on Safe Methods of Construction and Operation, any vacancies that may occur on the committee from time to time to be filled by the President.

The resolution was adopted.

The Convention then went into Committee of the Whole, which reported the rules in the form as printed on p. 313, which were adopted by the Convention.

MR. C. J. FIELD then read a paper on Electric Railway Construction and Operation.[1]

MR. BURLEIGH inquired what service was rendered by the local lighting company for the three cents per car mile.

Mr. FIELD answered that the actual service was to operate the generators which the street railway companies should install. He believed that the street railway company should install their own generators, because questions will arise about accidents happening to their own generators, and the station should only be responsible for ordinary wear and tear—not accidents due to short-circuiting, lightning or other causes.

MR. BURLEIGH inquired if Mr. Field advised central station men to attempt the care of overhead lines, the electrical part of the car equipment, etc.

MR. FIELD—In general I would say, No. I think that is the street companies' own business.

The Convention then adjourned until September 11, at 10 A. M.

FIFTH SESSION—FRIDAY, SEPT., 11.

The Association met at 10 A. M.

THE PRESIDENT—We will first take up the paper of Mr. J. I. Ayer, entitled : "Some Details of the Care and Management of an Arc Light System as Practiced in the 'Municipal,' of St. Louis."[2]

MR. AYER remarked that the paper being in print in the hands of the members, he would forego reading it but would add certain details not contained therein : In referring to the station, and in giving you this paper I have done so with the idea of bringing out, developing and inviting other papers of this nature. I want to say with reference to our station that the problem which I had there was different from that of almost any central station that I know of to-day. It was to start in and build a plant of large capacity, to spend money far in excess of the requirements of the business in sight, and to build a station which still had a very large business to start with. We already had a contract with the city of St. Louis for 3,000 lights, and the prospect was, when the station was first laid out, that it would ultimately absorb other companies and take in a number of smaller stations, as was afterwards done; and so my instructions were to build as large a station on a given piece of ground, which they handed over to me, as I could, and regardless of what it cost. I was confronted by a problem in that particular which will explain some of the peculiarities of construction which we adopted. I built a station with a working capacity for 6,000 lights, but when the station was put into operation it commenced with with 2,000 lamps. All the stations throughout the country which are in the hands of our members have, as a rule, grown up from small affairs. They started up in some junk shop or other, with a few dynamos, and grew as the necessities required ; and the result is that there has been an enormous amount of patchwork all the way through. But in our station there is nothing of the kind. We had to start off and build something which would be complete in itself, and which was comprehensive enough to take all the work in the near future that was likely to be drawn in it. Since putting the station in operation we have absorbed the other companies, and brought up the output of the station to the number of lights mentioned in the paper. At the time of building this station there was nothing of its character, size or magnitude in this country. The problem which confronted me, aside from the designing and construction of the station, was the system of management to be adopted, the methods to be applied, the details relative to the management of the men, and it all had to be worked out and put in motion with the wheels at the beginning. The plan that I outlined, the blanks that I made for the government of my men, are the ones that I am using to-day. I had made but few minor changes in the original blanks that were laid out beforetwe had done any work at all in the way of operating. And while, undoubtedly, we have followed

1. See page 303, this issue.
2. See page 312, this issue.

in detail many of the practices that have obtained in other central stations in the management of our men and in the division of the work, I want to say that I was unable, on applying to a number of cities, to get anything to assist me in arranging our blanks or system. It was a thing that could not be found. I have since found, in conversation with central station men who have large plants, that we have thought out the same ways, independently, of managing our stations—that we are working on similar lines. In some instances it is peculiar that it is so. One object of the paper in outlining the details of practice at our station is that that has not been done very much, and because I realized what difficulty I had in endeavoring to obtain information. In fact, I did not obtain any that was of value to me. That is my excuse in a measure for going into details of our plan of working to such an extent in this paper.

First, I will refer to our method of caring for the street lamps. We have got a number of street lamps distributed over a very large area. The city required that our lamps should be supported very high above the street. The minimum altitude of the lamps is thirty-five feet above the roadway. The city also required that we should suspend them between the poles. They were arbitrary in the matter. In order to get our lamps at that elevation the shortest pole that we could use was fifty feet in length. In suburban lighting they required the lamps to be fifty feet above the roadway, and they had to be suspended from sixty-five to seventy foot poles, according to the length of the space. The average distance apart is about 900 feet. I think that we have about 1,500 lamps where the average distance apart is 825 feet. The balance of them, 500 or more, have an average distance of 1,300 feet between the lamps. These are long distances.

In lighting the suburbs and, in fact, the whole city, we have found the use of a cart and horse very desirable. As stated in the paper, the average number of lamps per trimmer with a vehicle is sixty-eight. When one stops and thinks about the work, where lamps are located close together, of easy access, supported by methods which enable the trimmer to get quickly at the lamp, or even supported as mine are when they are placed so high above the streets, that looks like a small number; because we have, as doubtless many others have, some trimmers who care for more than one hundred commercial lamps per day. But we have got our lamps at this high altitude, and it takes a long time to raise and lower them. We are compelled to use a device for raising and lowering, a device which has to be lowered and locked in order to prevent its being meddled with, and that necessitates, each time, the unlocking of the device by the trimmer, applying the crank, lowering and raising the lamp; and, as the poles are set on the curb line of the streets, and passing vehicles could knock the device off easily, the hoisting device has to be placed up high out of the reach of the sides of the wagon, and that necessitated the use of a ladder by the men to get up to the hoisting device. It seemed to me, before we went into operation, that it would be essential that we should have something of that sort. We have a cart, modified to suit the requirements, and enabling our trimmers to carry extra globes, extra lamps, rubber clothing, means for keeping the carbons dry, and any number of tools that they wish (and we require them always to carry a few) and to carry the means to enable the trimmer to make any temporary repairs for the purpose of removing any defect or trouble which he may find. We have found that by furnishing our men with cart and horse (requiring them to furnish the horses) we have been able to employ men for $65 per month who are in every way equal to the men whom we employ for trimming commercial lamps, where they carry a step ladder around the town, at two dollars per day. For $65 per month we find them seeking the positions as trimmers. They furnish their own horses, feeding, shoeing and caring for them in every particular—leaving us only to supply them with vehicles and harness. The cost of maintenance for vehicles and harness is not very great. The cost of outfit was about $75 per trimmer. The cost of repairs and depreciation of harness and vehicle is about forty per cent. annually as we calculate it. That thing has been discussed somewhat, and in some other places they have tried the use of carts, and are not altogether pleased with them, but where the conditions are satisfactory I must say that we find much better results in the care of our lamps in that way than we have ever experienced with the same class of help. With $40 trimmers, such as we have, I doubt if we could get the results that we do in any other manner.

We have got a very useful little blank which I presume may be advantageously used in many other places. We have printed on it a form of telegraph pole with fifteen cross-arms on it, and ten pins. Although we use no more than eight pins for our work, yet we use other pole lines in carrying our wires over the city, and we keep a record of every pole and wire on those blanks. The location of the pole and the positions of the wires on the pole are indicated on the blank. From the corner of First to Tenth street, Circuit No. 5 will occupy the two outside pins on the top cross-bar, and the side of the street and the name of the street is given, so that by reference to that diagram at any time we know the exact location of our own and of other people's wires. In laying out new circuits and in doing additional work it is a very convenient thing to refer to, and it saves lots of work. It is very convenient where you have many poles, and especially where you have to run a mixed line, and interchange with other companies, to have some such arrangement.

In the care of a station it is rarely the practice in the smaller stations to have anything in the way of instruments except those furnished by the parent company, and possibly, sometimes, one outside instrument. We all know the utter unreliability of the ordinary commercial device furnished to us as an ammeter by these parent companies; and unless you do accurately know the amount of current, leaks will creep into the plant which I am sure would astonish any one if they were to go at the matter carefully and measure them. I do not think that there is a station in a town of 20,000 inhabitants and over, that can afford not to be provided with a high reading voltmeter (I am now speaking exclusively of, and referring only to, arc light circuits) that will measure the whole difference of potential on your circuits during the operation of them, so that you may know the amount of energy being consumed, and accurate ammeters are essential in order to know what that energy is. In the paper I have made a point of that. I will give you a statement of a little test. Until I had made the test and made the comparison I could not realize that the difference or the opportunity for difference was so great. With ten lamps adjusted to burn an average of 46 volts with 9.5 amperes of current, the average number of watts of the ten lamps was 436 per lamp. Now, without changing the adjustment of the lamps in any manner, but simply increasing the current so that the ammeter needle read 9.8 amperes, an increase of .3 ampere, you will find that the indicator furnished by our parent companies will not agree within half an ampere. With an increase of current of only .3 ampere the average consumption of watts was 534, or an increase of 20 per cent. in the watts consumed. That was the result of a change of only .3 ampere. When the current was increased so as to give the lamps ten amperes we had an average voltage of 58 volts per lamp instead of 46, an average of 550 watts per lamp, or an increase of 33 per cent. in the energy consumed. There is a saving equivalent to a very handsome profit on your lamps. We all know that often in a moderate-sized station some one will often come in and think the lamps are not in good order, and ask, "What is the matter with the lamps? Push them up." The ammeter is found to be all right, but still we give them more energy. Many of our superintendents want to have good lamps, and they want to make a good show with them, and so they keep their lamps bright in this manner. Now they will get just as satisfactory a light, and a more even light, by having the lamps properly adjusted and running them on a normal current, than they can possibly get in this manner, and be able to save from thirty-three to fifty per cent. of the energy consumed in those lamps. This is a point that I know a good many of you have already looked into, and you have discovered in practice that it is an opportunity for very serious leaks, but I have never heard any one bring it out before. This shows you the necessity of having a good and accurate instrument adapted to your work. Our practice is to take the commercial instruments furnished by the company whose apparatus we use, and then standardize them, regardless of their scale indicating where the needle should stand to indicate the currents that our lamps are adjusted for. We use two Weston ammeters as standard instruments. I find it desirable to have two, rather than one. Those we use almost entirely for standardizing these other instruments which we use in practice. There is something very peculiar about an ammeter. I find that they will run along perfectly accurate, and that two or three instruments will agree exactly for a week or ten days, and then, without any apparent cause, and when working under identically the same conditions, and connected together in series so as to take the same amount of current, the needle will vary sometimes as much as 0.2 or 0.3 on one instrument. Then we bring in our standard instrument and put it in the series in order to find out which one of those has changed its adjustment. It is something that we do not attempt to account for, grouped as they are, for this occurs in cases where we have them fastened to a board against a post, and where all the influences surrounding them are the same under all conditions and at all times, and they are not in close proximity to any wires carrying heavy currents, and there is no opportunity that I know of for change either in condition or position. And yet the change does occur. I think that money expended for good instruments to be used in adjusting lamps and in maintaining the current constant is money well expended. In operating the large number of lamps that we do, if we had an ammeter on every circuit (as some do) we would have a very variable condition of affairs. Of course these variations in ammeters would exist. We keep continually two ammeters in series. We have a very convenient plug and socket made for inserting the ammeter quickly in the circuit, so as to get it right in circuit. It is placed on the switchboard by simply inserting a single plug. Thus we connect the ammeter in series with the circuit. Our practice is in starting up, as soon as the dynamo is in operation, to insert the plug, and see that the current is what we desire to show by this instrument. We go through the whole series in that way, and that thing is repeated in our station every two hours during the night, and during the daytime once an hour we find it desirable to do this. While we have not much change in load we have changes in circuit conditions during the night, and the governors are not always responsive to a moderate change of load. You can easily build up your current 0.1, 0.2, or 0.3 of an ampere, and the governor will not always respond. We burn more carbon, and of course more coal, during that time.

This matter of circuit connection is often a fruitful source of trouble as well as one of the causes of an immense loss of energy, and is a thing that we all ought to pay close attention to. I know that all central station men now make it a practice to make a solid circuit making good line joints, but when we let out a lamp we are apt to have a binding post there, and we are apt to insert the wire in, either in the hanger board or on the lamp proper, and the man sets up the set-screw and leaves the lamp hanging there; then the wire will corrode and a condition will be brought about which will soon so disarrange things that a 50-light dynamo will run only 40 lights. We use hanger boards for suspending all our lamps, whether inside in commercial use, or outside in city use. The hanger boards are all provided with cutoffs. We took our boards as they came from the manufacturer, but shortly subsequent to that we soldered a short section of flexible insulated cable to the binding post of each hanger board, and then when the man cames along to make a line connection after the hanger board is put in place, he makes an ordinary line joint. Thus they get a good, solid, strong connection. The soldering that is done is done in our repair shop, or done at the station, where they have time to have it done well. Of course, a man cannot do a good job out in the wind, and under all the conditions usually existing, when he has to solder up a connection of that nature, and when an iron is obliged to be used to solder a wire to a binding post. We have all seen cases where cutouts on a line have soldered joints which had better have been left alone, and even with the solder left off. There is often a lot of acid left on so that the wire is corroded in a very brief time, or they get a little lump of solder piled up in one corner. The same practice obtains as to all the devices that we put in circuit. In cutout boxes we use the best flexible insulated cable, so that it may be put in and out many times, and leaves the connection unimpaired. We have those soldered to the hanger board binding post at the station. This leaves the lineman nothing but an ordinary line joint to make, which he can do outside easily and well. I cannot say that is done on all our circuits, because of the hurried way in which the plant was put in operation, and because we put in 1,200 lights at the very outset, and so there is more or less of the old construction which has not been overhauled. But generally we have no connections in our station except solid soldered connections, except where a lamp is connected to the hanger board. We have a hook hanger, and we also have a binding post on this hook on the lamp. We hook the lamp into the hanger board hook, and solder a short piece of cable which we put in a binding post, and bind it with a screw. Thus we get a double connection where we cannot have a solid connection. There is no hanger board that I have seen, and no method of hanging lamps by hook, or connecting them by a single connection to the hanger board, that will not develop trouble in ordinary practice, but by using the double connection you get very good protection.

I have mentioned in the paper that it is our practice to charge the customer for arc light installations. I am aware that this practice does not generally obtain throughout the country. One of my employees who came to me from an older company once told me that I was wrong in attempting this; that the thing could not be carried out; that it would make trouble and give us bother in endeavoring to collect from, or compel customers to pay for, arc light installations. I maintain that there is no more reason why we should do wiring free than there would be for a gas man to charge nothing for piping a house. There is no more reason why a gas man should pipe a customer's house than there is for our wiring a house free for incandescent lamps. Of course in the early days, when arc lights were still an experiment we were anxious to get the thing in a man's house so that he would try it, hoping that if he liked it he would keep it; and so we did not charge for wiring. And later on the same thing prevailed, and to get a customer started we were willing to do the wiring for the sake of getting him converted from the present method of lighting by gas to the new method by electricity. And so that practice has been followed up because the precedent has been established. We have effected a saving, or decreased our expenses, more than $600 per month by refusing to put in the lamps free. We make a charge of 35 cents per hour for all labor except that of the foreman, and we charge 40 cents per hour for his time. We also charge for the horse and wagon at the same rate, and we charge from the time the men leave the station until they return. That charge will usually cover the time of connecting it in circuit, and the cost of the minor things which we never take out—in the way of screws, insulators, and other such little things—and perhaps also the cost of removing the wires. We have another shrinkage there in the scrap wire which comes in, and which may, or may not, be recovered. But in a measure this charge covers largely the expense. We make a point with our customer that we want to own those appliances, that we bear the cost of them, but that we want to charge him for the labor, and we charge for the labor in that way. We do not pay those prices, you well understand, to our linemen. We own our own teams. The horse and wagon is worth $4 a day to us. Charging at that rate, they do not cost us anything. I know that there is a good deal of objection made to this plan, and in fact the president of our company said that I was taking a wrong stand, but it did not make any difference to me, and after the first few months all objections were gone. Many of our customers require only short service lamps, as from October to the 1st of January, or perhaps through the winter, taking them out in the spring, and we have customers who take lamps for six months in the year only, their business being of such a nature that they do not require them longer. These people want the lamps every year, but not for all the year, but still they do not want their wires taken out, and so, to save increased expense to them, and to avoid the taking out and putting in of wires, we require them to sign a contract when the period of service expires for the succeeding season. Then we leave the wires in, and agree to connect them without cost. But for our own protection we disconnect them entirely from the circuit. We always cut the wires out of the building, close the circuit at the pole, and take down the loop leading to it. I am satisfied that it is well worth the cost to do this, for then we are in no danger of burning them up, and by cutting them off, closing up and making a solid circuit we do not have to look for trouble from cut-out boxes, or other bad contacts, nor do we have trouble. The place where men never think to look for trouble is in those dead wires. They forget them. While this costs a little money, I think it saves a little in the end.

MR. NICHOLLS agreed with Mr. Ayer that wiring should be paid for by the consumer, and he followed that practice in his work with good results.

MR. FRANCISCO also concurred with Mr. Ayer, but showed how difficult it was to carry out this rule where there were competing companies in the same territory. He also bestowed high praise on Mr. Ayer's station, which he had visited. He always charged free wiring to expense and not construction account, as he considered it a dead loss.

MR. NICHOLLS—I am glad Mr. Francisco referred to the question of competition. I think it is better to sell your product at a lower price—to give a discount rather than to give something for nothing. You then know exactly what you are doing and exactly what you can afford to do. If you do free wiring I maintain that you have no right to charge it up to the capital account. You ought to charge it to the expense account. When once you wire a customer's premises he has you at his mercy. He can tell you to take your wires out. Whereas, if you meet competition by saying we will give you ten, fifteen or twenty per cent. discount, then if you have a row with your customer you simply lose his custom, but you are at no financial loss in the matter as regards the actual expenditure of capital, and I think that is a far more reasonable way of meeting competition—to sell the product at a lower price.

MR. FRANCISCO—I would say that I always charge free wiring to expense and not to construction or anything else. It is a dead loss.

MR. SEELY drew attention to the fact that three of the largest companies in New York city started to do free wiring. They spent half a million dollars before they realized the fact that it was an expensive luxury. It cost them on an average about three dollars to put in. They finally reached a combination whereby they agreed to charge the customer actual cost. Some en-enterprising gentlemen put the actual cost down to $1.50 a light. His opponent kept his price stiff at $3. The three-dollar man did not get the business. Finally the wiring got down again to about $1 a light. But he did not agree with the gentleman about the account to which wiring should be charged. In some large buildings there is $10,000 worth of wire alone. If you make a contract with a man to wire a building you make a contract with him to either buy that wire at the expiration of the contract or to remove it. It would be found that companies have spent thousands of dollars in wiring large buildings, and it would be nonsense to charge that to expense. Mr. Seely doubted the possibility of adjusting accurately all the arc lamps in a large station such as that of Mr. Ayer.

MR. AYER replied that he kept men specially on that work who with practice had become very expert at it. It could be carried out more easily in a large station than in a small one. Mr. Ayer tested all his lamps as they came from the manufacturer, employing boys in this work eighteen or nineteen years old. They are paid $35 or $40 a month for that character of work.

Mr. Orford thought that an arc lamp required only one adjustment. He had arc lamps in operation in stores for six years and they have never been touched for the purpose of readjustment. All that was necessary was a uniform current strength.

Regarding the question of renewals the only advantage which he saw in the customer buying his incandescent lamps would be that they could sell them in a bunch and have done with it, whereas they now supply them one or two at a time as required. The disadvantage of the customer buying his lamps had appeared to be that some of them might burn the lamps as long as they would burn, and in that way it would not be very creditable, as they have to compete with very good gas. If the Convention could help him in any way to kill competition in his town from a fellow member of the Association he would like to get some assistance.

MR. SCOTT had found considerable trouble with inaccurate measuring instruments furnished by parent companies.

He had done free wiring because the gas company had lowered its rates from $2 to $1.60 in order to compete with them, and had offered to pipe all large stores and residences free. But after firmly establishing the company he thought that wiring should be charged for.

DR. LOUIS BELL, referring to dynamo governors, stated that the best results could hardly be expected in actual practice when the best laboratory instruments will get out of adjustment with the most skillful use, and when they are subjected to a degree of care which could not be even approximated in the most refined commercial work. He thought that the cause of error that is so frequently made in ascribing exceedingly fine regulation to commercial apparatus was due to the fact that it is not sensitive enough to show more variation, and instanced examples.

MR. ORFORD replied, with the Weston instruments and Howell indicator he managed to keep his circuits at the proper voltage. He did not think it necessary to maintain the highest regulation on arc circuits, as a small difference could not be recognized.

MR. W. C. WARNER'S Paper on "Different Forms of Carbons Used in Arc Lighting" was then taken as read.

On motion it was resolved that the Rules for Safe Wiring, adopted by the Convention, be at once printed and a copy sent to each central station and insurance association in the United States.

On motion of Mr. FRANCISCO, Sir William Dawson, Mr. Frank R. Redpath and Prof. Henry T. Bovey were elected honorary members of the National Electric Light Association on the recommendation of the Executive Committee.

On motion of Mr. SEELY and by the recommendation of the Executive Committee, Mr. Thomas D. Lockwood was also elected an honorary member.

The Convention then went into executive session.

The Secretary presented the following report:

SECRETARY'S REPORT.

The condition of the Association, so far as its membership goes, is much stronger and more encouraging than it was at the opening of the year. Many individual memberships have been dropped since the adoption of the present constitution, owing to the fact that memberships are, under it, very largely represented by corporations and firms instead of individuals. Notwithstanding this fact, a quite large addition has been made. New members, since the last report of your Secretary, and the general interest in the affairs and work of the Association, have very largely increased, owing to the active agitation concerning the very important benefits arising from membership and the representative character of the Society.

According to the last Secretary's report, the number of member's who had paid dues for 1891 was as follows: Active members, 65; associate members, 107. Total, 172. The present membership stands as follows: Active members, 78; associate members, 142. Total, 220.

I beg to say, in connection with the total membership of this Association, that it is far from what it should be, and far from what it might possibly be made, in view of the immense possibilities for the diffusion of valuable information within its grasp. Our active membership list, especially, should be very largely increased, and could be by making an active membership a valuable consideration and worth more than the annual dues amount to, in the way of practical information furnished during the year. I would suggest that the Committee on Data be increased in its membership and that the collection and distribution among our members of important facts, figures and details relating to the furnishing of light, heat and power be carried out systematically, persistently, throughout the year. There is a vast field here for good, and I consider it as important a work as the Association has to do. Respectfully submitted.

On motion, the report was received and filed. The Treasurer's report was then presented by Mr. Beane, as follows:

TREASURER'S REPORT.

This report is made from April 1, dating from the beginning of office, until July 1, our fiscal year dating from January to July and July to January of each year. This report is based on the books of the Association and on the trial balance of the Auditor on April 17, and on my trial balance of July 1.

The operations of the Treasurer, as regards receipts, is indicated by Schedule "A," the total receipts being $1,265 Total disbursements amount to $1,387.62, making the disbursements $122.62 over the receipts for that period. The proof of this is contained in the following: Balance in the bank April 17, indicated by the auditor's trial balance, was $1,373.15. Balance in bank July 1, indicated by trial balance, $1,122.02. Cash on hand July 1, $128.51. Total of cash on hand July 1, $1,250.53. Which total is $122.62 less than the amount on hand April 17, proving the difference between the receipts and disbursements as indicated by the report. The assets of the Association on July 1st consist of cash in bank, $1,122.02, and the value of furniture account charged with $214.15. The assets were further increased by the payment of the Committee on Exhibits of moneys disbursed, and their account is Schedule "B." Respectfully submitted.

The report was, on motion of Mr. Seely, referred to the Finance Committee.

DR. MASON offered the following resolutions, which were unanimously adopted by a rising vote:

The National Electric Light Association, assembled in Montreal, at the close of its session desires to put upon record its appreciation of the distinguished honor shown it by the Dominion of Canada in the presence of His Excellency Lord Stanley of Preston, Governor-General of the Dominion—

Of the large-hearted hospitality of the city of Montreal, evidenced by many grateful acts, official and individual—

Of the tireless industry of the Citizens' Executive Committee, whose efforts have carried to completion the most successful meeting in the history of this body—

Of the grand work done by the Committee on Exhibits, issuing in an exhibition of rare educational value, calculated to develop a larger appreciation of the flexibility of electricity and its wide adaptation to human needs—

Of the gracious liberality of McGill University, which has lent the dignity of its great name and the personal influence and labor of its officials to the success of our meetings—

To the Press of this city, whose extensive and fair reports of our meetings have extended our influence—

To the railway companies for their liberal reduction in fares, and to the Windsor Hotel management, where as guests we have found a home.

Resolved, That the above minutes be placed on the records of the Association and a certified copy thereof be sent to the various bodies mentioned.

On motion of MR. SEELY, seconded by JUDGE ARMSTRONG, the following resolution was adopted:

Resolved, That a vote of thanks be tendered Mr. J. I. Gulick for the efficient and successful management of the exhibition now being held under the auspices of this Association, the largest ever held on this continent; and that the Secretary be directed to have this resolution engrossed and presented to Mr. Gulick.

On motion of MR. SEELY, seconded by DR. MASON, a like vote of thanks was extended to Mr. Luther Stieringer.

MR. FREDERICK NICHOLLS, MR. M. D. LAW and MR. A. M. YOUNG were elected as members of the Executive Committee of the third class.

DR. MASON gave notice of the following amendment to the constitution: "That in the first article the word 'International' be substituted for the word 'National,' so that the title of the Association would be, 'The International Electric Light Association.'"

Buffalo was selected as the place for holding the February meeting of the Association.

On motion of MR. SEELY, a vote of thanks was extended to Mr. Allen R. Foote for his services.

The Convention then adjourned *sine die*.

INCIDENTS AND ENTERTAINMENTS.

A LARGE number of the delegates with the ladies of their party reached Montreal by the special trains on Sunday, Sept. 6, from Bostona nd New York, the latter being under the special direction of Mr. C. O. Baker, and the former under that of Mr. A. C. Shaw. The trains were united at Rutland, Vt., and by the process of gathering up other delegates en route, the special when it pulled into Montreal had at least 200 passengers on board. It was also accompanied by a number of local friends and members who, with bagpipes to the fore, boarded it some distance from the city. The party arrived about midnight. It deserves mention also that many of the delegates made their way to Montreal by the pleasant route of the Lakes.

On Tuesday the entertainments began at 2.30 P. M. with a fire department display on the Champ de Mars. Owing to the adjournment of the Convention daily at 2 o'clock, it was easy to combine work with play, and many members with their ladies attended. Thence they adjourned to Terrace Bank, the residence of Mrs. F. R. Redpath, who gave a garden party in their honor. The same evening a conversazione was given at the Redpath Museum and Molson Hall, McGill College, where the gathering was very large. The committee who received were Sir Donald A. Smith, Mr. and Mrs. F. R. Redpath, Mr. Peter Redpath, ex-Mayor and Madame Beaugraud, and Prof. and Mrs. H. T. Bovey. Not only were the permanent buildings open, but a large tent was erected specially to serve as a refreshment hall.

After luncheon on Wednesday, about 150 carriages were drawn up in front of the Windsor, and the delegates and a large number of their friends entered and went for a drive around the heights of Mount Royal. The visitors enjoyed the trip very much, especially the magnificent view from the look-out. In the party were Mayor McShane, Ald. Clendenning, Ald. Cunningham, Ald. Stevenson and a number of prominent citizens. They arrived back in the city in time to attend the garden party at Belmont Hall, 537 Sherbrooke street, the residence of Mrs. John Molson, where a delightful hour was spent in social intercourse.

Sir Donald A. Smith, who throughout took great interest in the Convention, giving his countenance at the opening and extending his hospitality to many of the members, entertained a party of gentlemen, consisting of citizens of prominence and members of the Association. Among the party were President Huntley, vice-presidents James I. Ayer and John A. Seely, J. W. Beane, secretary; Cap. Eugene Griffin; Samuel Insull; G. W. Davenport, Frank R. Redpath, T. C. Martin, Judge Armstrong, S. Dana Greene, C. W. Price, Gen. C. H. Barney, Peter Redpath, W. C. McDonald, Sir J. William Dawson and others. There were about fifty at table. After dinner an hour of keen pleasure was spent in inspecting Sir Donald's picture gallery, rich both in old masters and in modern art, containing a magnificent Turner, Jules Breton's "Communicants," a Tissot, a Constant and many others of equal merit.

An impromptu ball was given in the Windsor the same evening and proved a decided success. The credit of this is mainly due to the indefatigable efforts of Mr. John Carroll, the genial secretary of the Reception Committee. The Ladies' ordinary of the Windsor was tastefully fitted up for the occasion, and proved very suitable for the purpose. Quite a number of Montrealers were present, among them being Mayor, Mrs. and Miss McShane, Mr. and Mrs. Hagar, Miss Christie, Mr. and Mrs. David Starr, Ald. Stevenson, Consul-General Knapp, Miss White, of Ottawa; Mr. John Carroll, and many others. The officers, all of the delegates and the ladies of the Association were present and enjoyed the affair very much. Dancing was indulged in until after midnight to the music of a full orchestra. Light refreshments were served during the evening in the new club rooms.

The morning session was so fully occupied on Thursday that many had scarcely time to catch the steamer Filgate for the Lachine Rapids trip at 2.30 o'clock. Among the city men present were Messrs. Henry Bulmer, the chairman of the harbor commissioners; John Kennedy, harbor engineer; Ald. Stevenson, Ald. Villeneuve and Prof. McLeod. On passing the Eugene Phillips' electrical works the party found it handsomely decorated with flags and streamers in their honor, and nearly every operative, male and female, was at the windows waving flags. Lachine was reached in due course and a short stop was made at Caughnawaga. The party did not leave the boat, but amused themselves by tossing coppers and aluminum medals to the boys and watching the scramble. The run down the rapids was thoroughly enjoyed by all. The water was comparatively low and gave a good idea of the dangers of the narrow passage, as the boat tossed about here and there in close juxtaposition to the rocks. The visitors were loud in their praises of the outing and everyone enjoyed it. The city was reached about six o'clock.

The evening of Thursday was devoted to the banquet tendered the Association by the citizens of Montreal, and given in the fine Windsor Hall. The room was beautifully decorated with flags, plants, flowers, etc., and the tables were laid for about 500 covers. The arrangements had been made and carried out by Messrs. John Carroll, chairman; W. E. Christie, John Kennedy, S. C. Stevenson, A. J. Corriveau and G. B. McFarlane, and were admirable. Sir Donald A. Smith presided, and among those present were the Governor-General, Lord Stanley of Preston, Lord Kilcoursie, A. D. C., Sir William Dawson, Sir Henry Edwards, Mayor McShane, ex-Mayor Beaugrand, U. S. Consul General Knapp, Justice Baby, Justice Cross, Prof. Bovey, Justice Doherty. Before the regular proceedings began, Mr. T. C. Martin, in the name of his fellow-members, presented Prof. H. T. Bovey with a phonograph as a little souvenir and in recognition of his work as chairman of the Citizens Committee. After the toast of the Queen, that of that of the President of the United States was given, and responded to by Consul General Knapp. The toast of the Governor-General was responded to by Lord Stanley in a most happy manner. Ex-Mayor Beaugrand then proposed the health of the N. E. L. A., and President Huntley responded in an excellent speech, which he concluded with a pressing invitation to the Chicago meeting in 1893, when the countersign would be "Montreal, 1891." At this point Sir Donald Smith presented Mr. Huntley with a beautiful ebony mallet mounted in gold and bearing his name engraved upon it. Judge Armstrong then proposed "The City of Montreal," to which Mayor McShane, Mr. Justice Cross, Mr. Hugh McLennan, Ald. Rolland (in French) and Ald. Clendenning responded. Gen. Barney then proposed the toast of "McGill University," to which Sir William Dawson made an admirable response. The toast of "The Citizens Committee," proposed by Mr. J. I. Ayer, was responded to by Mr. John Kennedy, Mr. A. J. Corriveau, Mr. J. Carroll and others. After the toast of the ladies, the "Electrical Press" was responded to by Mr. G. M. Phelps, and "Electrical Science" by Mr. T. D. Lockwood. The banquet then concluded, as it began, to the stirring strains of the bagpipe, played by kilted Highlanders.

The festivities of the week may be said to have closed on Friday, when a large party watched an exciting lacrosse game between the Montrealers and the Cornwall Island Indians, at the grounds of the Montreal Amateur Athletic Association. In the evening At Homes were given by Mrs. Frank Redpath at Inglenook and by Mrs. Bovey at Sunnandene.

An interesting episode of the Convention was the visit paid to the Exhibition by the Governor-General on Thursday. Lord Stanley spent the morning in a close and careful examination of the exhibits, and soon betrayed an intimate acquaintance with mechanics and with the various ideas embodied in the electrical appliances for the distribution of light and power.

A more perfect day could not have been conceived than that which dawned on Saturday morning on a party of about 75 who responded to the invitation of Madame Louis Givernaud, Mr. Alex. Macdonald, and Mr. J. B. Tresidder to join them on a cruise up the Richelieu River as far as Fort Lennox, known as the Isle au Noix. Special cars had been provided on the 9 o'clock train on the Canadian Pacific Railroad to Iberville, whence the start was made. At the wharf, where the three private steam yachts laid waiting, the guests were received by Madame Givernaud, Mr. Macdonald and Mr. Tressider, with Mr. Corriveau as introducer of the party. The guests were then divided among the three yachts which were all gaily decked with flags, the Stars and Stripes occupying a prominent position in honor to the American guests. After a loud tooting of whistles a start was made, and the three yachts got fairly on their way, and by a little dexterous manœuvering, were kept almost side by side where the width of the channel permitted it. The weather was beautiful, the sun shining brightly, and a refreshing breeze blowing, which seemed to infuse new life into the most of whom were fatigued by a week's hard work and late hours. In a few minutes all were comfortably settled in settees or chairs, while others lounged on the deck and gave themselves up to the full enjoyment of the hour. After an hour's sail up the river, the scenery on which is extremely beautiful in a quiet, restful way, a landing was made at the Island, and the whole party soon distributed themselves over the fortifications and barracks, speedily gathering together again, however, at the call of lunch, which was served on impromptu tables set out in the shade of one of the buildings, the guests seating themselves on the banks of the fortifications. Here an excellent repast was made, and the walls soon resounded thereafter with three times and a tiger for the lady and gentleman who had provided so royal an entertainment. Other toasts followed, after which the party reluctantly returned to the yachts, a number of them having to hurry off to catch the 3.30 train to Montreal. Quite a number, however, lingered behind, and as they were too late for the train, Madame Givernaud, with true Canadian hospitality, took half them to her house and entertained them to dinner, while Mr. Macdonald divided the courtesies with her by entertaining the others in his home. A quiet stroll through the quaint old town, a visit to the large China factory owned by Mr. Macdonald, and a peep at the old church whiled away the hours in a thoroughly pleasant manner. At 7.30 the train was taken for return to the city, the guests, even with all American fluency, being quite unable to express their thanks for such a perfect day's enjoyment. There has been much, very much, to be enjoyed in Montreal by the kind hospitality of Montreal's citizens, but those who were fortunate enough to go on the yacht party will never, it is safe to assert, forget the beauties, the hospitality, the perfect enjoyment and rest of that day on the Richelieu River.

EXHIBITION NOTES.

THE ELECTRIC MERCHANDISE COMPANY, of Chicago, had one of the most interesting exhibits at the Convention, though they confined themselves to a parlor of the hotel, in the shape of several Burton electric heaters, in charge of Mr. D. B. Dean and Mr. W. R. B. Willcox. Current could not be secured till evening, but every evening they made an interesting exhibition of the Burton heater in operation, and attracted a great many people by its novelty. The heaters exhibited were designed for street car work, and are installed in cars two on each side, all four being in series. The heaters exhibited were operated by a 110 volt circuit, taking from 3 to 4 amperes, and become too hot to touch with the hand 5 minutes after the current is turned on. The heating is accomplished by about 70 feet of German silver wire, which is prevented from oxidizing by being imbedded in fine brick-dust. They exhibited a very complete assortment of electric railway supplies, consisting of pole ratchets for tightening the span wires, and also trolley hangers, Chicago clamps, trolley wheels, and raw hide pinions, which are made from plain raw hide, and have no glue or paste between the layers, being formed with 25,000 pounds pressure, and cold-riveted. A novel and useful headlight for electric cars was also shown, having a triple silver-plated reflector with an incandescent lamp of any desired candle power, the connections with the car being made by a flexible conductor in rubber tubing.

HOLLAND BROTHERS & YOUNG, of Montreal, exhibited to the great delight of all Montrealers a number of Edison phonographs in active operation. The neat room which they had fitted up with various cabinets was crowded all the time, and the expressions of wonder and delight which these little instruments elicited were alike interesting and instructive—instructive of how little the general public yet understands of the many wonders of electricity.

THE INTERIOR CONDUIT AND INSULATION COMPANY, of New York, made a very handsome display of their regular line of interior conduit, mounted on a large panelled board. The tubes of the conduit are also covered with steel or brass, making them extremely durable and serviceable. Connection boxes and junction boxes were shown in their proper place, and well displayed the many good qualities of the system. Attached to the exhibit, and forming a part of it, was displayed the Johnson vise-lock switch for currents from 50 to 100 amperes. These switches form the most compact and smallest ever shown for such large currents. The vise-lock switch does not depend upon springs for contact, but the contacts fit firmly into jaws. A sample of the Johnson underground conduit was also shown, for carrying all kinds of cables, either of high or low voltage. Another interesting feature of this exhibit was the California arc lamp, which burns 90 hours without change of carbon and which throws no shadows underneath. The lamp measures only 14 inches over all, and the carbons are shaped like horizontal quadrants, about six inches wide, the arc playing between them, and feeding across the whole extent of the edge surface. The Interior Company are sole agents and manufacturers for the United States and Canada, east of the Rocky Mountains. The Garland carbon protector also formed part of the exhibit. Mr. E. W. Little, general manager, and Mr. Paul Oscanyon, assistant electrician, were in charge of the exhibition.

THE MCGILL UNIVERSITY, of Montreal, had secured for themselves a neatly arranged kiosque in the exact centre of the hall, and kindly exhibited several pieces of interesting apparatus. They showed a chronograph, connected to a brake circuit chronometer for determining the clock error by the transit of stars; a Thomson composite electric balance, a Thomson voltmeter, ranging from 500 to 10,000 volts, a multicellular voltmeter, instruments for the determination of longitude, and a few very interesting samples of the kinematic models for the study of motion. The kiosque was under the superintendence of Prof. McLeod and Prof. Nicholson, and Prof. Bovey also gave considerable attention to the exhibit, in the midst of his arduous duties as President of the Citizens' Executive Committee, for the entertainment of the members of the National Electric Light Association. Mr. Carroll was fortunate enough to secure a good photograph here of the vice-regal party, consisting of the Governor General, Lord Stanley, his aide-de-camp, Lord Kilcoursie, and Sir Wm. Dawson, while resting in the exhibit of the Eugene Phillips Company, during their visit to the exhibition hall.

THE EUGENE F. PHILLIPS MANUFACTURING COMPANY, of Montreal, were represented at the Convention by Mr. Eugene F. Phillips, president; Mr. John Carroll, secretary and treasurer, and Mr. Frank S. Mead, general manager. Mr. P. C. Ackerman, of the New York office of the American Electrical Works, was also present. The Phillips Company had a very tastefully arranged exhibit in the centre of the hall, capped by a broad sign board with electric lamps forming the word "Phillips." They exhibited handsome samples of all kinds of magnet wire, office and annunciator wire, flexible cords, telephone cords, switch cords, telegraph and telephone cables, rubber insulated wires for electric light and power, and numerous reels of nicely finished weatherproof line wire. Mr. Carroll, who is now located in Montreal, has endeared himself to all the members of the Convention by his unvarying good nature and attention, and his phenomenal efforts to entertain one and all.

THE CONSOLIDATED ELECTRIC MANUFACTURING COMPANY, of Boston, represented by Mr. C. E. Bibber, exhibited a neat sample board on which were displayed samples of the new C. E. M. socket, C. E. M. jack knife switches, cut-outs, Davis arc cut-outs, and other supplies. The most interesting feature of the exhibit, however, was the Wade dynamo register, which automatically records the working of every arc light circuit in a station. This instrument, which is manufactured exclusively by the Consolidated Company, is intended to be installed in the superintendent's room, and has a clock attachment, carrying a revolving disc of paper upon which a pencil attached to an electromagnet bears. The electromagnet is in series with the dynamos and lamps, and every flash of the dynamo is thus accurately recorded on the dial, so that the superintendent in the morning has a perfect record of the running of the dynamos during the night, and the time to a second when the lights were turned on and off. Should the circuit be broken, the armature of the electromagnet is released, and makes contact with a local circuit which rings a bell and alarms the attendant.

ALEXANDER, BARNEY & CHAPIN, of New York, were represented by Mr. P. H. Alexander—what would a convention be without him?—and Mr. Henry G. Issertel. They had no exhibit of their own in the hall, but showed, in one of the parlors of the hotel, a complete set of samples, consisting of A. B. C. incandescent lamps, the Bernstein series incandescent lamps, French yachting horns, and a very neat display of all kinds of push buttons and electric bells, of all sizes and descriptions. They also showed A. B. C. sockets, tapes, switches of all makes, Alexite cut-outs and rosettes, and A. B. C. splicing torches.

THE HEISLER ELECTRIC LIGHT COMPANY, of Philadelphia, were represented by Mr. Oscar Hermann, who exhibited a 200 light 32 candle power incandescent dynamo for series long distance incandescent lighting, and an automatic regulator which is belted to the dynamo. The armature of this dynamo is stationary, with a rotating internal field, and is divided into two circuits, so that should one coil burn out, one-half of the machine could still be operated, and keep half the lamps burning. The exciter is on the same shaft, and is part of the machine. Between the exciter and the armature is a fan revolving on the main shaft for ventilating and also for the expulsion of dust. The Heisler Company also exhibited their series incancescent lamps and sockets which run on a 5 ampere circuit, and range from 5 to 100 candle power. These lamps were shown mounted on street fixtures, and also on decorated fixtures for house use.

THE ELECTRIC ENGINEERING AND SUPPLY COMPANY, of Syracuse, N. Y., were represented by Mr. F. H. Leonard, Mr. L. C. Hinds, Mr. J. D. McIntyre, and Mr. F. Hawkins. They exhibited a large sample board on which were the initials E. E. S. in Packard frosted lamps, for which they are the agents for Canada and the Eastern States. On the top of the board they showed a distinct novelty in the shape of clusters of various colored lamps which were made to revolve by an electric motor behind the scenes. They also showed a very handsome assortment of large and small knife switches and electric railway supplies, trolley hangers, various E. E. & S. sockets, rosettes, cut-outs, branch blocks, &c., 5 to 10 ampere switches, and a new double pole 5 ampere switch just got out.

CHARLES A. SCHIEREN & COMPANY were represented at the Convention by Mr. Charles A. Schieren, Jr., of New York, and Mr. G. H. Hamblett, of Boston, who were probably the two most disappointed men in the hall. With their usual energy they had prepared a very attractive and tastefully designed booth for the reception of their goods, but, alas! "the samples that they looked for never came." Mr. Schieren stated that they had a very interesting, complete set of samples, but they had been delayed on the Canadian Pacific Railway, and could not be found. Nothing daunted, however, Messrs. Schieren and Hamblett stuck to their post, and drew word pictures of the peculiar excellency of their dynamo belts to their numerous friends.

THE PHOENIX GLASS COMPANY, of New York and Pittsburgh, as usual, had one of the most beautiful displays in the hall, attracting special attention among the ladies, as their goods lend themselves easily to decorative purposes. Mounted on red cloth, they showed in great profusion, and artistically arranged, samples of glass shades for gas and electric fixtures, plain, richly cut, tinted and etched, making a very beautiful effect. They also showed a number of round balls of the Star and Hobb cut, and had suspended in front of their stand a large ball 12 inches in diameter. Mr. A. H. Patterson and Mr. E. H. Peck looked well after the interests of the Phœnix Company.

THE ECONOMIC ELECTRIC MANUFACTURING COMPANY, of Boston, manufacturers of "Economic" incandescent lamps, were represented by Mr. N. V. Titus, of Boston. About 150 of these lamps were used to decorate the kiosque of the Simplex company, and produced a very fine effect, being of all colors. The Economic lamp has got a fine foothold in Canada, and are handled exclusively by the Canadian Electric Supply Company, of which Mr. Corrivieu, is the head. Mr. Titus is a Canadian by birth, having been born in St. Johns, and during his leisure moments, had the pleasure of meeting many of the friends of his boyhood and visiting the scenes of his early youth.

THE PAGE BELTING COMPANY, of Concord, N. H., were represented by Mr. J. H. Burghardt and Mr. C. W. Currier, of Boston. They displayed samples of various styles of belting, especially the Eureka dynamo belt made with slots specially for dynamo work. Samples of the 30 inch and 16 inch belts recently made for the Georgia Electric Light Company, of Atlanta, Ga., were shown. Mr. Burghardt seemed to be everywhere in his particularly felicitous way, and made friends wherever he went. The value of Page belting and Burghardt are synonymous, and he will find many friends in Montreal whenever he returns.

MR. T. W. NESS, of Montreal, had a very complete exhibit of all kinds of push buttons, annunciators, telephones, batteries, telegraph instruments, induction coils and medical batteries, and all household goods. A C. and C. motor was also shown driving a sewing machine. Mr. Ness also showed a very convenient combination of switchboard and telephone, which is particularly applicable to factories having several 'phones in the building, as it is only necessary to turn the arm of the switch to any desired point, when communication is instantly afforded to any of the various telephones in the building.

MILLER BROTHERS & TOMS, of Montreal, exhibited samples of the famous Hill friction clutch, so commonly used in electric light stations, and showed a few interesting photographs of stations using this clutch. They are the Canadian agents for the Hill Friction Clutch Company, of Cleveland, O.

THE WESTON ELECTRICAL INSTRUMENT COMPANY, of Newark, N. J., showed an extremely handsome assortment of voltmeters, with multipliers, ammeters, station ammeters, and new alternating current voltmeters. The Weston new alternating current voltmeter is accurate to ½ of 1 per cent., and can be adjusted to any temperature. It has a brake on the movable coil to stop the vibration of the needle. The new station ammeter is well worthy of interest, and is quite new. It is accurate to one per cent., and is made to read up to 2,000 amperes. The company was represented by Mr. Wm. Moore and Mr. Wallace Hill.

THE DOMINION WIRE MANUFACTURING COMPANY, of Montreal and Toronto, were represented by Mr. A. E. Hanna, and exhibited an exceedingly attractive display of brass and copper wire for electrical purposes, galvanized iron and steel telegraph and telephone wire, barbed wire, chains, screws, nails, and some very neat sample boards tastefully designed for the occasion. All the wire is drawn in their factory at Montreal, and the copper comes from Lake Superior.

MR. M. C. SULLIVAN, of New York, exhibited samples which he carried in his pockets—a new electric slate, which he is going to push for all electrical insulating purposes. The particular feature of this slate is that all the deleterious substances have been removed by a patented process, leaving the pure slate as an excellent insulating material, and removing all the objectionable features which have hitherto attended the use of slate for high tension insulation.

THE JOHNS PRATT COMPANY, of Hartford, Conn., and New York, exhibited a neat sample board on which were mounted samples of Vulcabeston goods for insulating magnet coils of dynamos and motors, trolley hangers, and various samples of electrical appliances where good insulating material is required. Mr. J. R. Burdick, of New York, representing the H. W. Johns Company, and Mr. E. R. Hatch, of Hartford, looked after the interests and future welfare of Vulcabeston.

MR. ALFRED E. BRADDELL, of Philadelphia, electrical inspector of the Underwriters' Association of the middle department, and W. H. MERRILL, JR., of Boston, electrical inspector of the Boston Fire Underwriters' Union, attended the Convention and listened with interest to all that was going on.

PASS & SEYMOUR, of Syracuse, N. Y., exhibited samples of almost every conceivable appliance in which porcelain can be used for electrical purposes. These pieces were all made out of superior porcelain for which Pass & Seymour have earned a wide reputation for its excellence. The porcelain was shown also in various colors, and Mr. A. P. Seymour, who was in attendance, showed also a very handsome tea set made out of the same material.

THE PETTINGELL-ANDREWS COMPANY, of Boston, were represented at the Convention by Mr. C. B. Price, of Boston, who was always on hand to explain the mysteries of K. W. cut-outs and rosettes, a few of which were exhibited in the stand of the Toronto Construction Company, who are their agents in Canada.

GEORGE CUTTER, of Chicago, exhibited his famous lamp-supporting pulley in operation, and Mr. Cutter was in attendance to explain to his many friends "why the lamp did not drop," as the explanation has never been published. The only feature missing was the little devils on the suspending rope, which have become so familiar to all by his clever advertisement.

THE UNION ELECTRIC MANUFACTURING COMPANY, of Bridgeport, Conn., showed, in conjunction with the Toronto Construction Company, samples of their new sockets, switches, single and double pole, and Mr. J. M. Orford was in attendance looking after the interests of his company, as well as representing the Bridgeport Electric Light Company.

THE JENNEY ELECTRIC MOTOR COMPANY, of Indianapolis, exhibited, in conjunction with the above exhibit, a 7½ h. p. Jenney electric motor, and a Jenney dynamo. These motors and dynamos are equipped with their new carbon brushes, which bear vertically on the commutator, and the carbons of which are kept in good contact by a series of springs.

DANSEREAU'S ELECTRIC WIRE SUBWAY SYSTEM was exhibited by itself, and attracted some attention by its possibilities. The subway is built at the sides of the street, next the curb-stone, and the model showed a section of the street at a crossing, and was very complete in every detail.

ROBERT MITCHELL & COMPANY, of Montreal, had a very pretty exhibit of all kinds of electric light fixtures and brass and bronze chandeliers, all manufactured in Montreal. They were of extremely tasteful design and presented a very pleasing appearance. Mr. Robert Mitchell represented the company.

THE PERU GLASS AND CARBON COMPANY, of Peru, Ind., showed samples of glass jars and carbons for all kinds of batteries. They had mounted on one of their boards a large piece of carbon about two feet long and four inches in diameter. The Peru Company will make carbons for any style of battery.

THE CROCKER-WHEELER MOTOR COMPANY, of New York, was represented by Dr. S. S. Wheeler and Mr. George W. La Rue. They exhibited a $\frac{1}{16}$th h. p. 10 ampere arc motor driving a 16 inch fan, and a ¼th h. p. arc motor, with a new automatic governor for controlling the speed. Fireproof indestructible resistance boxes and regulators combined were also shown in operation, by which any speed on a motor may be obtained. They showed a 1 h. p. 110 volt incandescent circuit motor, of the reversible type, which can be run in either direction without changing the position of the brushes. This motor was shown driving a 5 light dynamo of the new pattern, with a new style of ventilated armature. The regular $\frac{1}{16}$th h. p. fan outfit was shown and the "La Rue combination" electric fan, consisting of a ¼th h. p. electric motor, mounted on a fan base and driving a 24 inch exhaust fan 600 revolutions per minute. Both the motor and the fan were provided with self-oiling bearings. In another part of the hall they exhibited a ¼th h. p. fan outfit, and a Crocker-Wheeler "Infant" dynamo, of two light capacity. They also showed Crocker-Wheeler motors driving sewing machines of various sizes. The exhibit was in charge of Mr. La Rue.

THE INTERNATIONAL OKONITE COMPANY, of New York and London, had a very tasteful display of their wires and cables, and were represented by Capt. Willard L. Candee, Mr. George T. Manson and Mr. Jean A. Wetmore. They showed a very complete lot of sample reels of all kinds of wires and cables, underground and submarine. Two large drums of "Acme" lead cable, recently described in the columns of THE ELECTRICAL ENGINEER, were shown, these cables being specially designed for high tension underground work. Aerial wire, lamp cords, Manson and Okonite tape, improved Candee wire, were all displayed in profusion, there being a large pyramid of Okonite and Candee tapes in the centre of the exhibit. Special mention should also be made of the very handsome sign board on the grand staircase of the hotel, with the letters of the name and address of the company all made out of submarine armored cable of large size, and tastefully arranged.

THE HART AND HEGEMAN MANUFACTURING COMPANY, of Hartford, Conn., were represented by Mr. G. W. Hart, the inventor of the well-known Hart snap switch. They exhibited a complete line of these switches from 5 ampere single pole to 100 ampere double pole. The 15 ampere double pole switch, which they have just brought out, was shown and attracted considerable attention on account of its accurate work and exceptionally long break. Mr. Hart also showed a sample of a 100 ampere double pole switch mounted on slate, with connections arranged so as to conveniently fit on to the bus wires in a central station. The movements of Hart switches are all rotary, the make and break are instantaneous, and the current passes from one contact to the other through solid metal and not through pivoted joints.

THE GLOBE ELECTRIC CORDAGE COMPANY, of Philadelphia, exhibited samples of their flexible silk and cotton-covered cords for incandescent work. To show the excellence of their manufacture, an incandescent lamp was shown burning through a flexible cord which was immersed in a jar of water.

THE AMERICAN CIRCULAR LOOM COMPANY, of Boston, were represented by Mr. A. S. Clark, of Boston. As advertised, Mr. Clark was forced to make "moonlight" excursions to show up the peculiar virtues of his insulated wire.

ALUMINIUM CARBON COMPANY, LIMITED, of Buffalo, had their representative, Mr. Fred. V. Doty, on the ground to look after their interests. If personal appearance can sell carbons, the Aluminium Company ought to do a large business.

THE MASSACHUSETTS ELECTRICAL ENGINEERING COMPANY, of Boston, were represented at Montreal by Mr. R. Vose, who circulated around in a modest manner, leaving neat little sample bobbins of tested fuse wire wherever they would be appreciated.

C. MCINTYRE & COMPANY, of Newark, showed samples of their valuable McIntyre connectors, and Mr. C. H. McIntyre looked well after the interests of his company in his usual happy and affable manner.

WM. SCLATER & COMPANY, of Montreal, exhibited a comprehensive sample lot of all kinds of asbestos covering for steam pipes, cotton waste, and asbestos packing for cylinders and piston rods.

THE NATIONAL CARBON COMPANY, of Cleveland, were well represented by Mr. C. D. Smith, who quietly distributed numbers of their useful electrical directory, and talked "carbon" when desired.

THE PERU ELECTRIC MANUFACTURING COMPANY, of Peru, Ind., exhibited a fine sample board containing a number of their special cut-out and branch boxes of all sizes, made out of porcelain.

THE THOMSON-HOUSTON INTERNATIONAL ELECTRIC COMPANY was represented by Mr. George W. Davenport, Mr. Lomax, Mr. Chauncy Belknap, Mr. J. W. Kirkland, and Mr. J. H. Waterman, who had complete charge of the erection of the exhibit, and who accomplished wonders in the short time at his disposal, having set up over 40 tons of material in less than two weeks.

THE TORONTO CONSTRUCTION AND ELECTRIC SUPPLY COMPANY, of Toronto, Can., were represented by Mr. Fred. Nicholls, manager, and Mr. George C. Stannard, who was in charge of the exhibit, and Mr. A. J. Christie, of St. Johns, N. B. They exhibited a large board showing the new "Vulca" ducts and interior conduit, recently brought out by the New York Insulated Wire Company. The board was fitted with all the necessary junction boxes, branch boxes, elbows, bends, and samples of connections were exhibited to show how to make joints in the tubes. The system is completely worked out, and everything is now in readiness for the complete equipment of buildings. The ducts are made of a rubber compound, are perfectly water-proof and have a certain amount of elasticity. This is the first time tne system has been shown. Mr. James W. Godfrey and Mr. George H. Meeker, and Mr. Augustus Noll, of the New York Insulated Wire Company, were in attendance to explain the system. All types of Grimshaw wires and cables were exhibited, and rolls of Grimshaw tape. The Toronto Company are sole Canadian agents for the Grimshaw and "Vulca" specialties. The Toronto Company also exhibited three Ward arc lamps, for which they have the Canadian agency, one working on a 50 volt alternating circuit and two on a 110 direct incandescent circuit. Crocker-Wheeler motors, already noticed, were shown in operation, one of them driven as a dynamo, by a 1 h. p. Eddy motor, exhibited by the Toronto company, as agents for the Eddy Electric Manufacturing Company, of Windsor, Conn., who were represented at the Convention by Mr. A. D. Newton and Mr. M. E. Baird. The Toronto Company showed also a complete imported line of very beautiful switches, cut-outs and rosettes, and showed samples of Samson batteries, Hussey blue stone batteries, Crosby dry batteries, flexible brackets, cigar lighters, and all sorts of household goods. A line of instruments from James W. Queen & Company, of Philadelphia, were exhibited, as also instruments from the Standard Thermometer Company, of Peabody, Mass. At the back of the exhibit, hung on the wall, were large sample boards showing a complete line of goods, including bells, annunciators, push buttons, etc., manufactured by The Partrick & Carter Co., of Philadelphia.

THE RIES ELECTRIC SPECIALTY COMPANY, of Baltimore, Md., represented at the Convention by Mr. Elias E. Ries, president, and Mr. Lewis S. Greensfelder, vice-president, exhibited a regulating socket for alternating circuit incandescent lamps, by means of which the brilliancy of the light can be varied as desired, from full brilliancy to a dull red when the lamp is only consuming about one-tenth of the current consumed when burning up to full candle-power. One is thus enabled to handle the lamp in the same manner as has been customary with gas jets. A sample lamp fitted with the Ries socket was shown with a small ammeter in circuit, and as the lamp was "turned down" it was clearly shown that it consumed current proportional to its brilliancy. This device thus saves a large amount of current, when the lamp is not required to be up to candle-power, and, it is claimed, saves the filament of the lamp, as the current cannot be switched on suddenly, but has to pass all the gradations of the socket. The Ries Company are making two sizes of these regulating sockets, one for lamps from 16 to 25 c. p., and the other for lamps of from 32 to 50 c. p. There is no resistance used in the mechanism, but the working of the socket depends upon a small choking coil. Though a small exhibit, it attracted a vast amount of attention, the novelty of being able to "turn up or down" an electric lamp appearing to attract not only electricians, but the general public in large numbers. The Ries socket may be said to have formed the most interesting feature of the exhibition.

THE STANDARD UNDERGROUND CABLE COMPANY, of Pittsburgh, New York and Chicago, were represented by Mr. George L. Wiley, of New York, and Mr. J. W. Marsh, of Pittsburgh. The exhibit, though not large, was unique in its way. The initials of the company, "S. U. C. Co.," formed of rolled brass, about a foot long, were mounted on a wooden base, and short samples of underground cable were attached to the frame work of the letters, making a very pleasing combination. There was also a sample board containing a few samples of the 82¼ miles of underground arc light, incandescent and power cables recently sold to the Minnesota Brush Electric Company, of Minneapolis. Samples were also shown of 1,750,000 feet of No. 4 B. & S. wire, sold for underground work in the cities of New York and Washington.

THE RUSSELL ELECTRIC COMPANY, of Boston, were represented by Mr. H. E. Chapman and Mr. H. Dewar, and exhibited the Russell disc carbon arc lamp, which is now so widely and favorably known. Two 18-hour and two 12-hour lamps were shown, though most attention was paid to the "Baby" lamp, which measures only 27 inches over all, and 23 inches from the hanger board, and burns eight hours at 1,200 c. p. The Russell lamps have now been tried for nearly a year in practical work and are giving good satisfaction all over the country.

THE STEELE & JOHNSON MANUFACTURING COMPANY, of Waterbury, Conn., were represented by a Mr. A. H. Mills, who carried most of his exhibit around in his pocket, in the shape of incandescent lamp shade-holders and other samples of sheet metal work, turned work of every description, castings, and machine screws.

GERMANIA ELECTRIC COMPANY, of Boston, represented by Mr. Otis K. Stuart and Mr. Harry Bottomley, made a very beautiful and interesting exhibit of the improved Schaefer incandescent lamps and Freeman transformer. The design for showing the lamps was unique in its way, and attracted a good deal of attention by its clever arrangement. In the back of their exhibit was situated a large white cabinet with gilt moulding, containing fifteen folding shelves or drawers. On opening these shelves rows of incandescent lamps were displayed upon various colored felt background, which, as the shelf was lowered into a horizontal position, became illuminated, the current entering through a brass quadrant attached to each shelf. On these shelves were mounted various designs of the improved Schaefer lamp; some being ordinary plain glass, others colored by a special imported process, by which the fading of the color is made impossible. There were also exhibited a number of lamps showing the Khotinsky matting process on the lamp, by which an effect is obtained similar to ground glass. These matted lamps give an apparent increase of candle power, though there is an actual loss of somewhat less than five per cent. In other shelves were shown lamps with double filaments, lamp with twisted filaments, and lamps with tied filaments for railway work, the filaments being tied by small platinum pieces to prevent their vibration. The current for these lamps was derived from three Freeman transformers, mounted at one side of the exhibit, which have only recently been put on the market. They are built on an entirely new design and are said to be the lightest transformers made. In one corner of the exhibit was shown an elegant piano lamp, showing the application of the incandescent lamp for this purpose, and on a table was displayed a very tastefully designed fanciful exhibit representing a camp fire, with a pot boiling. The effect was produced by placing a red colored lamp amongst a number of twigs representing a log fire, over which was suspended a purple colored lamp in a white opal shade, which resembled a pot hanging over a camp fire for the preparation of the evening supper. In addition to the lamps, the Germania shade holder and socket were shown, the shade-holder especially attracting much attention amongst electric light people, as it has no detachable parts nor screws to work loose.

H. WARD LEONARD & COMPANY, of New York, were represented by Mr. H. Ward Leonard and Mr. A. S. Vance, and showed an entirely new method of operating an electric motor, extremely interesting to electricians, as results are achieved never before thought possible. Mr. Leonard showed an Edison dynamo furnishing current direct to an Edison motor, which was geared direct by a worm wheel to a hoist, which raised and lowered a heavy weight. By Mr. Leonard's arrangement, the speed of the motor, as well as the torque, can be varied independently, and the number of watts required by the motor varied directly with the work done under all conditions. This system or arrangement is not only new in electric devices, but is an entirely new principle in mechanics, for up to the present time there never has been any motor, steam, water, gas, electric or otherwise, which would enable one to attain any speed desired, and hold that speed constantly, when the load varied from zero to its maximum. The control of the motor is effected by an electric device, which consumes only a quarter ampere. The speed is increased or decreased at will, and the direction of rotation can be instantly changed. The application of this principle is almost universal, the most important being to hoists, railways, elevators, pumps, planers; in fact, to all classes of work in which it is desired to vary the speed and vary the pull or torque. Mr. Leonard cannot disclose at present the principle underlying his invention, owing to his foreign patents, but will read a paper soon before the American Institute of Electrical Engineers, when the system will be fully explained. In the exhibit shown it was decidedly curious to see a motor doing heavy work, while the armature was only running at a very few revolutions per minute, in fact, just visibly crawling round.

THE NORWICH INSULATED WIRE COMPANY, of New York, were represented by Mr. F. Day Voorhees, who had fitted up for them a very tasefully designed stand. The exhibit consisted of a number of reels and coils of saturated and dry paper insulated, lead covered underground wires for electric light and power, high insulated line wire, house wire, office wire and waterproof magnet wire. All these wires and cables are covered with paper insulation specially prepared, the waterproof magnet wire making a particularly interesting exhibit to builders of electrical apparatus, especially those who build railway motors. A new form of T and straight splice for arc light underground joints was shown, consisting of a brass casting in halves, with a recess to fit the cables and a rubber gasket, also in halves, to protect the bared part where the joint is made. The two halves of the casting are then screwed tightly together, making a perfectly waterproof joint. The cables of the Norwich company are all covered with lead at their own factory, by a special patented process of their own, which is subject to no royalty.

L. E. WILCOX & COMPANY, of Meriden, Conn., exhibited a number of their "Speed" wire stretchers, which are calculated to save a large amount of labor in running wires and enable a wireman to make work neat and symmetrical.

THE CANADIAN ELECTRICAL CONSTRUCTION, MANUFACTURING AND SUPPLY COMPANY, of Montreal, were represented by Mr. A. J. Corriveau, whom everybody knows, and to whose untiring efforts much of the success of the Convention was due, from a scientific and social point of view. To describe his exhibit, is impossible, as he represents (we prefer to call the exhibit Mr. Corriveau's, as we strenuously object to print more than once the headline under which this note is written. The name of the company is all we have against Mr. Corriveau) many of the exhibits already enumerated, amongst which are the Thomson-Houston International Electric Company, the Fort Wayne Electr c Company, the Excelsior Electric Company, the Simplex Electrical Company, the Crocker-Wheeler Motor Company, the Economic Electric Manufacturing Company, the Bryant Electric Company, the Standard Oil Filter Company, and many others. Mr. Corriveau's headquarters were in the kiosque, built especially for this exhibition by the Simplex Electrical Company, of Boston, and described elsewhere, but he was to be found everywhere, attending to everybody's wants, and giving all a true Canadian welcome. His efforts to entertain and please will not soon be forgotten.

SIMPLEX ELECTRICAL COMPANY, of Boston, the manufacturers of the famous wire upon which the "Sun Never Sets," had probably the most artistically designed exhibit in the hall. In the centre part of the building they had erected a beautiful kiosque of unique design, built entirely of wire, and manufactured at their own factory in Boston. This was lit up by Economic incandescent lamps, and made a specially attractive display. Mr. Corriveau used the kiosque as headquarters of his exhibit, and had installed in it a small desk and comfortable chairs for his own and the Simplex company's many guests. The word "Simplex" in large letters adorned the the top of the kiosque and reels of Simplex wire were displayed all around. It was whispered also that a large amount of Simplex wire had been used for the wiring of the numerous exhibits in the hall. Dr. A. F. Mason, of Boston, was in attendance at the Convention, as usual, renewing many old friendships and making many new ones.

THE STANDARD PAINT COMPANY, of New York, manufacturers of the famous P. & B. compounds, were represented at the Exhibition by Mr. R. L. Shainwald and Mr. Frank S. DeRonde, of New York, and Mr. W. W. Castle, of Boston, who interviewed their numerous friends beside two tables representing the letters P. & B. They showed a sample representing the roof of a central station painted with P. & B., and carrying two poles painted with P. & B. and supporting P. & B. insulated wire; also a complete sample of P. & B. paints, tapes, armature varnish, insulating compounds, and papers. A genuine stuffed rooster, the trade mark of the company, graced the exhibit, and bore in its beak a small incandescent lamp. Mr. Castle also showed samples of P. & B. conduit, which is handled by a separate company.

THE JEWELL BELTING COMPANY, of Hartford, Conn., occupied a prettily draped booth, and had a variety of samples of leather belting on exhibition. Mr. C. L. Tolles had the honor of representing the Jewell company alone as Mr. C. E. Newton found it impossible to be present, much to the regret of his many friends. The exhibit consisted of a 30-inch double belt for the Manufacturer's Electric Light Company, of Philadelpha, and several other double belts built for electric railway work, made of especially thick leather for this purpose. A picture of the factory adorned the exhibit, and also a photograph of the heaviest belt in the world which the Jewell company built some time ago, and which weighs 2,730 pounds, is made four ply, and transmits 1,500 horse power.

MR. FRED. W. ROYCE, of Royce & Marean, of Washington, D. C., without whom no convention would be complete, was on the ground and exhibited the Carpenter storage battery. The active material consists of native carbonate of lead or "Cerusite," which is contained within a hard rolled lead shell which is perforated, to admit of the circulation of the electrolyte. It is claimed that the cell will not buckle and the active material is so held that it is impossible for it to become separated from the plate. The cell is said to weigh from one-third to one-half less than the usual type of storage cell for the same output. A local company has been formed in Washington to exploit the Carpenter battery.

THE STANDARD ELECTRIC TIME COMPANY of New Haven, Conn., represented by Mr. C. D. Warner and G. W. Hutchinson, had an interesting exhibit of the Warner system of electric time, furnishing accurate time to the exhibition hall. In the small space allotted to the company they had fitted up one self-winding regulator fitted with the Warner system, which furnished electric time to three 24" dials, and six smaller dials distributed throughout the hall, in various departments. They showed also an ordinary self-winding clock and a synchronized self-winding clock. In addition to the clocks the well-known Warner electric gauges were shown, both for station and battery use.

THE THOMSON ELECTRIC WELDING COMPANY had an interesting board mounted with a complete line of samples of copper, brass, rods, chains, etc., welded by electricity. The exhibit was included in Mr. Corriveau's territory.

THE E. S. GREELEY & COMPANY, of New York.—Among the scientific and technical class of visitors at the exhibition great interest was taken in the exhibit of this company from the distinctively pronounced character of their display in standard measurement apparatus, embracing as it did their American pattern of the Thomson galvanometer, with various modifications and patented improvements, also several types of galvanometers, such as the Western Union Standard, Helmholtz Gaugain, half-meter ring, sine and tangent combined, and particularly a model of a new form of Ballistic galvanometer, which has not yet been placed upon the market. In fact, a line of galvanometers so complete as to fill every requirement in all departments of electrical measurement.

Not less complete was the display of rheostats, testing sets, high resistance boxes, many of which latter were of new design, in addition to their regular advertised lines of portable apparatus and standard resistance boxes.

Their telegraph department was also well represented by the renowned prize-winning Victor telegraph-key, with sounders, relays, switches, and incidental apparatus innumerable. Their improved ink-recording register was deserving of special mention, as it is so justly a favorite in Morse, district telegraph and fire-alarm work, owing to its accuracy and reliability. A peculiarity in the service of this register is its employment on railroad and other telegraph lines in the capacity of a "tell-tale," as its provisions for self-starting and self-stopping enable it to make a complete record of all that transpires on the wire during the day without waste of space or paper and permits each day's work to be filed away, giving a complete record for future reference.

In addition to the above was shown a full line of electric light and power appliances, amply testifying in their character and number not only to the difficulties of keeping pace with electrical progress in this direction, but also the fact that the Greeley Company succeeds in doing it. Electric bell, burglar and fire-alarm and general house supplies with their annunciators push buttons, and other paraphernalia were displayed in full force. Of the only two primary batteries put on exhibition at Montreal, one was presented by the Greeley exhibitors, and that one was the now well known Champion Battery, which for the past year has been exciting the attention of all users of this class of goods. It has been remarked by Custom House officials that outside of those exhibiting expensive apparatus, such as large dynamos and motors, the Greeley exhibit, probably, intrinsically represented the highest value of any contribution sent into the country, while the decoration of their booth was everything that taste, skill, patriotism and liberality could suggest.

THE FORT WAYNE ELECTRIC COMPANY, of Fort Wayne, Ind., had in their exhibit one 750 light compound-wound "Slattery" alternating dynamo. Off this machine were run about 150 incandescent lights which were used to light the "kiosque" where Mr. Corriveau had his office. They also exhibited one 15 light "Wood" arc dynamo, with full complement of lamps. This machine was used to light that part of the building in which the exhibit was situated. The Fort Wayne Company have very generously donated this arc apparatus to the Department of Applied Science of the McGill University. The alternating machine has been sold to the Electric Light & Power Company, at Lachine, (together with a 50 light "Wood" arc, 1,200 c. p). Power to run this exhibit was furnished by the Royal Electric Company from their works, over a mile from the exhibition hall. A 50 h. p. generator and two motors, one 15 h. p. and the other 35, manufactured by the Thomson-Houston Company, Boston, were used to transmit this power. The belting used by the Fort Wayne Company on their exhibit was furnished by the Charles A. Schieren Company, New York. This exhibit also contained two Bradley alternating fan motors which were very much admired. The Fort Wayne Company were represented at the exhibition by their general agent, Mr. W. J. Morrison. Mr. R. L. Denis was the electrician who had charge of the plant.

THE ENGINEERING EQUIPMENT COMPANY, of New York and Boston, were represented by Mr. F. A. Magee, of Boston, and Mr. W. F. D. Crane, of New York. They exhibited samples of the Anderson trolley, the new Ætna lamp hanger, indurated fibre pipe, and samples of Underwood cotton leather belting. Mr. Magee is a valuable man on such occasions due to the fact of his large acquaintance amongst electrical people. So, too, with Mr. Crane.

THE HAZELTINE ELECTRIC CO., of St. Louis, were represented by Mr. Hazeltine, who showed in the Fort Wayne exhibit, on an arc lamp, his "carbon protector," which has been illustrated in THE ELECTRICAL ENGINEER, and which serves to prolong greatly the life of the carbon, and thus cuts down the labor required in trimming.

ROBIN & SADLER, of Montreal, exhibited a few samples of leather belting, made for the Royal Electric Company, of Montreal, and showed their special dynamo belt.

DRAKE, PAYSON & WHITTIER, of Providence, R. I., were represented at the Convention by Mr. R. H. Whittier, who appeared to enjoy the Canadian hospitality to the full.

THE ELECTRICAL PRESS was very much to the fore as usual, all the papers being well represented. Mr. Fred DeLand acquitted himself nobly on the familiar bulletin of *The Electrical World;* while *The Electrical Age* also, for the first time, went into the bulletin business in great shape, its sheet being partly printed in colors—besides securing some excellent group portraits of the delegates. THE ELECTRICAL ENGINEER, besides holding a long reception from Sunday to Sunday in its hotel parlor, had a space reserved in the exhibition for the general distribution of copies of the paper, circulars, etc.

THE WESTERN ELECTRIC CO. were represented by Mr. S. A. Chase, who had a genuine "multum in parvo" exhibit in some wonderful trunks, which seemed to contain everything but a telephone exchange and a central station. Mr. Chase has shown great judgment in collecting his samples and still more success in selling from them. He has recently been making an Eastern trip, and found his way to Montreal in search of new worlds to conquer.

JAMES W. QUEEN & CO. were adequately represented by Mr. E. G. Willyoung and by a small but excellent display of their apparatus, including the new photometer, illustrated in these columns last week; a new portable testing set, a combined portable galvanometer and battery "fault-finder," and a new design of Siemens electro-dynamometer.

THE ABENDROTH & ROOT MFG. CO., mindful of the fact that steam boilers are a big feature in central nations, distributed copies of their very handsome pamphlet on that subject, describing their own well-known apparatus, and embracing much valuable data.

THE GOULD PACKING CO., of East Cambridge, Mass., exhibited samples of their steam and water packing that has become so popular in central station steam plants and is in rapidly increasing demand.

THE CARD ELECTRIC MOTOR AND DYNAMO CO., of Cincinnati, gave away copies of the handsome and instructive catalogue recently issued by them, descriptive of their well known motors, &c.

THE RELIANCE GAUGE CO., of Cleveland, O., called attention to their various good qualities of their Reliance water columns, in the way of securing vigilance from employees, economy in fuel, increased safety, etc.

JAMES LEFFEL & CO., of Springfield, O., circulated copies of a new and useful catalogue describing their various productions and giving a good deal of valuable information as to turbines and other power transmission machinery.

THE PRIOR INSULATING JOINT, was also shown in Mr. Corriveau's headquarters, though Mr. Peck, of Boston, carried one around in his pocket and showed it to all interested in this class of goods.

LEWISSOHN BROS., the great copper house of New York, were on the spot in the person of Mr. S. Rosenstamm, whose good humor reflected a rapidly improving condition of the market with many large sales.

THE BROOKS CARBON WORKS, of Peterboro, Ont., were represented by Mr. J. W. Taylor. This concern is in the field to produce carbons in Canada the equal of any made in the United States.

THE E. P. GLEASON M'F'G CO. were represented by Mr. W. F. Cullen, who made a neat display of their glassware and various electric light details in his room at the Windsor Hotel.

THE SHULTZ BELTING CO., of St. Louis, were represented by their vice-president, Mr. W. P. Mullen, of Boston, who showed some fine samples of their products.

THE BRIDGEPORT BRASS CO. was represented by Mr. H. D' Stanley, who bore the burden of responsibility with his accustomed cheeriness and alacrity.

MR. H. A. ROGERS, the well-known dealer in New York in electrical and machinists' supplies, was an attendant at the Convention.

THE SMITH & VAILE steam pumping machinery was represented by Mr. J. M. Duncan, who distributed pithy literature on that subject.

FELTEN & GUILLEAUME, of Germany, were to have made an exhibit of their wires and cables, but it did not arrive on time.

THE NEW YORK BELTING AND PACKING CO., of New York, were on band with a variety of printed matter, data, &c.

GOULD & EBERHARDT, of Newark, N. J., circulated descriptions of their admirable drill presses, machine tools, etc.

THE EDISON GENERAL ELECTRIC COMPANY, CANADIAN DISTRICT.—The largest exhibit in the hall was made by the Edison Company, who occupied floor space extending the whole length of the hall and across one-half. The motive power was derived from the McGill University, where there was installed a small power plant, consisting of a 150 horse power Laurie engine, a 120 horse power Edison 500 volt generator, and a 50 light Edison arc light dynamo. The current was brought over No. 00 wires to a 500 volt 120 horse power motor in the exhibit, which was belted to a 100 horse power generator, which furnished current to all the Edison exhibit and to various lamps distributed through the hall.

An interesting feature of the Edison exhibit was the miniature central station, deriving its power from a 1 horsepower motor. Two ¼ h. p. generators were shown coupled up as a three-wire system, through a regular station switchboard, to a complete system of underground Edison tubes. In the centre was a junction box, one feeder running into it, and two service taps connecting with mains, forming a square with joint boxes and everything complete. The junction box was shown open and in section, to show clearly the inside wiring. The little station was shown in actual operation and furnished current to two chandeliers, one at either end of the hall. Three braiding machines were shown working, making silk-covered cord, and driven by a 1 h. p. motor. A ¼ h. p. motor was shown, driving a Wing disc fan, and a 1 h. p. motor was keeping the air circulating by being coupled to a Sturtevant blower. A large reel of lead-covered cable was in close proximity to these exhibits, and also coils of copper wire drawn at the Edison works at Peterboro, Ont. In the middle of the floor was arranged a very beautiful stand of flowers, interspersed with incandescent lamps of all hues, topped by a bronze figure of "Night" holding over her head an incandescent lamp in the shape of a sphere. Here also were exhibited an Edison diamond drill, an Edison coal cutter, and an Edison percussion drill. An interesting board was set up in the middle of the exhibit, containing a number of very beautiful specimens of amber mica, taken from the Lake Girard Mines, at Wakefield, P. Q., Can.

Crossing the centre aisle of the exhibit, the beautiful fixtures attracted the eye, the fixture in the centre exhibit of the hall being valued at $600. A most complete line of fixtures was shown of most elegant design, made in bronze and other materials, with all kinds of lamps, including their most recent product, the beautiful "candle lamp." This is a lamp shaped like a wax candle, containing an incandescent filament, and being rated at 16 c. p. The effect of this lamp is distinctly novel and attractive.

Near by was shown a 30 light Edison arc machine, and a complete line of Edison dynamos from 80 h. p., tapering down to a ¼ h. p. machine. In connection with this was also shown a miniature dynamo, with complete working parts, the whole machine measuring but 1 inch high and 1 inch long.

Passing along, the lamp shades of very beautiful design formed a pleasing picture, and a sample board of all kinds of incandescent supplies also attracted attention. Some of these shades were very artistic, one being shown of ruby cut glass worth $22.50; the aluminum shades were also much admired. An interesting board containing samples of incandescent lamps in all stages of their manufacture attracted much attention. At the extreme end of the exhibit were shown glass cases of all kinds of Edison supplies, Edison-Lalande batteries, meters, wires, cables, magnet wire, office wire, flexible cords, and a large rack containing samples of all sizes of Edison underground tubes. In the gallery the Edison company exhibited a Huntington search light, receiving current from one of their generators.

The exhibit was in direct charge of Mr. F. A. Barr, of the Edison Canadian district, ably assisted by Mr. W. R. Rosenstengel, to whom great credit must be given for affording so complete and interesting an exhibition of the Canadian Edison industries.

THE THOMSON-HOUSTON INTERNATIONAL ELECTRIC COMPANY, of Boston, made a very complete exhibit of electric light and power appliances, covering about one quarter of the floor space of the hall. As in the exhibit of the Edison company, the electric power was derived from a generating plant at the McGill University, consisting of a 120 h. p. McIntosh and Seymour engine, driving two 50 h. p. 500 volt Thomson-Houston generators. Six No. 0 wires conducted the current to their main switch-board in the exhibit hall, which was fitted up with a main switch, and four circuit switches, the current being distributed by bus wires. From the switchboard, current was taken to a 75 h. p. motor, which furnished the power to drive a 650 light alternator and exciter, lighting a bank of 400 lights under the band stand, and also a series of twenty 50 c. p. lamps distributed on goosenecks round the exhibit. A 45 h. p. motor was shown driving a 50 light Excelsior arc dynamo, furnishing current to 7 arc lights outside the building and 12 arc lights inside the building, and also to a 10 h. p. Excelsior motor. In connection with these dynamos and motors were shown an alternating switch-board, complete with resistance boxes, ammeters and voltmeters. The new arc light plug switch-board was also exhibited, fitted with lightning arresters, and all in complete working order. Coming down to smaller sized motors, a 15 h. p. Thomson-Houston motor was shown driving a 15 h. p. 110 volt incandescent dynamo, lighting 100 16 c. p. lamps distributed throughout the building. This dynamo was also used to furnish current for the Crocker-Wheeler exhibit, the Thomson-Houston International Company having recently been appointed exclusive foreign agents for the Crocker-Wheeler specialties.

Next in order was shown a 10 h. p. motor driving a special generator of 220 volts, supplying current to operate a Van Depoele reciprocating rock drill, being equipped with a third revolving brush, the invention of Mr. C. J. Van Depoele. This dynamo also furnished current for a 15 h. p. electric hoist, used to raise a 500 lb. bale of cotton, and to a 5 h. p. electric mining pump. A special feature to be noted about this generator is the fact that it was shown operating ordinary rotating armatures and was at the same time furnishing current for a reciprocating drill. This part of the exhibit was furnished with a special switch-board, which had also mounted upon it various meters, all in operation, measuring the current being consumed from the McGill University, and also the current going out from the various dynamos shown in operation. These meters are the same type as those which were awarded the first prize this year at Paris. In connection with this switch-board was also shown a bank of 20 incandescent lamps controlled by a dimmer, as used for theatre work. The electric hoist shown was equipped with a 15 h. p. motor, geared to the drum by means of a friction clutch and strap brake for lowering. The electric pump shown was manufactured by the Goulds Manufacturing Company, of Seneca Falls, N. Y., and is fitted with three cylinders 4 x 6, with a capacity of 100 gallons per minute, and operated by a 5 h. p. motor on the same base, specially waterproofed.

The Thomson-Van Depoele rock drill exhibited was of the type known as "D." and is equipped with drills to make 1½ to 2 in. holes. Practical experiments in the hall showed it to have a penetrating capacity of about 2½ inches per minute on hard granite. There is no make and break of the electric circuit in the plunger, and the plunger is always magnetized in the same direction. At the further end of the exhibit there was erected a pyramid of wood fitted with 21 type "S" transformers, all in service, connected up in ten circuits of 40 lamps each, each circuit being controlled by a switch on the pyramid. A sample board was also shown containing a complete line of switches, cut-outs, etc., also all electric light supplies. A Robinson radial car truck fitted with two 15 h. p. single reduction motors completed the exhibit. A neat little office was annexed at one end for the reception of guests.

The Ferracute Machine Company, of Bridgeton, N. J., were represented by Mr. Fred. F. Smith, secretary and treasurer. Mr. Smith showed a pamphlet giving cuts of their various presses, from a small foot-press up to presses weighing 20,000 pounds, for the manufacture of all kinds of metal goods required in electrical work. Their presses are divided into five different kinds, as follows: (1) Presses for punching out tin and brass and light metals. (2) Heavier presses for cutting thick metals and also for shearing and punching. (3) Double action or drawing presses for producing all kinds of deep articles in sheet metals. These machines are extensively used in electrical work for parts of electroliers, gauges, push buttons, shells and parts of lamps. (4) Very large presses for cutting out armature discs, and large sheet metal work. In connection with these presses, Mr. Smith showed some photographs of a mammoth cutting press, the largest ever built in this country, being 100 inches between columns, having a total length of 12 feet, and weighing 19,000 pounds. To show the size of this large press, a photograph was displayed with seven men with their shoulders and heads extending through between the jaws of the press. (5) Punching and shearing presses for heavy girder, bridge, and other heavy work. The machines of this class stand high, but occupy a very small floor space. The Ferracute Company also make dies of every description to suit the above machines, and exhibited a number of samples of the kind of goods manufactured by these machines. They are at present getting out special presses for coining, and have recently built some machines for the United States Mint.

The Eureka Tempered Copper Company, of North East, Pa., had a very interesting exhibit of their goods in charge of Mr. N. S. Possons, general sales agent, assisted by Mr. J. B. Phillips. Mr. Possons was for 12 years general superintendent of the Brush Electric Company at Cleveland, and brings a valuable practical experience to aid him in selling the Eureka metal. On a convenient board the Eureka Company exhibited samples of commutator segments and brushes for arc and incandescent dynamos, finished commutators, samples of tempered wire for trolley work, or for work where great strength is required. They showed also the Eureka trolley wheel which is made with detatchable sides, the centre piece being tempered extra hard, and having a metal-line bushing. A large number of samples were also shown as they come from the sand, sheet metal in all thicknesses, bearings, soldering irons of various sizes, one of them being of immense size for soldering trolley joints. It is worthy of note that the tensile strength of Eureka tempered copper wire is increased to 64,000 pounds per square inch, with a compression strain of 109,000 pounds to the square inch.

The La Boiteaux Electric Motor and Fan Company, of Cincinnati, O., attracted vast attention with their novel oscillating fan motors, and were represented by Mr. F. M. La Boiteaux, the inventor. The motor is fixed upon an upright shaft which is considerably out of line with the centre of the motor. The natural effect is, therefore, when the motor is running, for one side of the motor to recede, and as it continues receding the motor slowly revolves, distributing the blast of air in every direction, instead of in one unvarying direction. This style of motor is specially adapted for setting in the centre of a room. The action of the oscillating motor is as follows: A bracket is supported from the base of the motor, supporting a horizontal flat surface shaped in a circle having for its centre the centre of the motor, or vertical shaft upon which the motor oscillates. The shaft of the armature extends out to this bracket, and in turning with the motion of the armature, its friction on the horizontal bracket causes the motor to oscillate in one direction until the shaft is carried past the bracket. Its motion is then stopped by rubber covered stop-pins and the shaft then comes back to the bracket, but this time rotates on the underside of the bracket, and as the armature is always running in one direction, the direction of oscillation is thereby changed. The principle is extremely simple, but ingenious and effective, and makes a very convenient combination for fitting up on one wall or corner of a room, as it assists in distributing the breeze over its entire area, and is undoubtedly a great improvement upon existing fan motors.

The Ball Electric Light Co. of Canada, Toronto, Can., were represented by Mr. W. A. Johnston, manager, and had an interesting exhibit of the Ball apparatus, which is peculiarly different in design from any other type of dynamo. First, they showed a 7 h. p. Ball 500 volt motor driving a 75-light incandescent dynamo, which furnished current to numerous lamps all around the exhibit. Another 7 h. p. Ball motor was shown driving a Ball double armature, two commutators, four ampere 35-light arc dynamos, furnishing current to about a dozen arc lights distributed round their space. These dynamos are capable of furnishing three 1,000 c. p. lamps to the horse-power and are largely used for factory and other kinds of internal work, besides street use. The Ball single-carbon arc lamps use a $\frac{7}{16}$ carbon, and as they run on only four amperes, they will burn all night without retrimming. This apparatus is all made in Toronto. In connection with this exhibit it may be noted that Mr. H. M. French, of Boston, was present, looking after the interest of Ball apparatus in general, and laying in a stock of information.

The Bryant Electric Company, of Bridgeport, Conn., were represented by Mr. W. C. Bryant and Mr. L. W. Eston. They made a very handsome display of the famous Bryant sockets, switches, cut-outs, and Orford pendants. The switches shown were for five and ten amperes, and they showed their new style of five ampere single pole switch, which has been so favorably received. The Bryant Company have just brought out a very interesting and beautifully illustrated catalogue of their goods, a copy of which every one in the electrical business ought to secure. The samples were all neatly mounted on a handsome board, specially designed for this Convention.

Delaware Hard Fibre Company, Wilmington, Del., represented by Mr. W. H. Stanhope, displayed a beautiful lot of samples of their product, embracing all kinds of insulated parts of electrical devices. Hard fibre tubes, rods, magnet heads, switch handles, washers, gear wheels, special parts for switches were displayed in great profusion, and made a very pretty exhibit. Hard fibre is now used for almost every kind of purpose, and it is hard to imagine any insulated part of a machine which cannot be made out of this material.

The Bernstein Electric Co., of Boston, had their exhibit adjoining that of the Ball Company and took the current from the Ball dynamos for their lamps. They showed a few very handsome interior or house fixtures for the Bernstein series lamp, and also showed the famous Bernstein street fixture and lamp, which is so well-known for municipal street lighting. These lamps were shown operating in series with the Ball arc lamps. They exhibited also a number of their switches, sockets, cut-outs, etc., and various apparatus required in the Bernstein series system. Mr. Henry B. Cram, of Boston, treasurer of the company, was present.

The Perkins Electric Switch Manufacturing Company, of Hartford, were carefully attended to by Mr. F. A. Davis, of Hartford, who had displayed in the centre portion of the hall a neat sample board of the well-known Perkins electric switches, sockets, and rosettes. In the centre of their board was shown one of their large 100 ampere switches, which attracted considerable attention by its clever arrangement and accurate workmanship.

Standard Oil Filter Company, of Chicago, showed one of their Ellis Filters, which have became so familiar a figure in electric light stations, and which are guaranteed to save central station men large quantities of oil in the course of a year.

THOMPSON & ROBERTSON, of New York, had an excellent exhibit of their new fibrous battery under the charge of Mr. Louis Walsh, who is ever ready to see his friends and impart information on the wonderful virtues of his new battery. Mr. Walsh is justly proud of the fact that he was the only exhibitor who had exclusively batteries to show. His pluck is to be admired. One of the fibrous batteries was shown ringing a bell, and at the time of writing these notes had been running continuously for four days, and showed no signs of abatement.

J. FITZGERALD, Montreal, exhibited in a convenient corner of the hall, an ingenious combination gas and electric universal bracket, with universal joints so that the bracket can be turned in any direction. The gas is conveyed in a small rubber pipe inside the brass pipe, and the electric wires are cotton covered and also run in a small rubber pipe, which is then twisted round the rubber gas pipe.

THE FIBRONE COMPANY, of New York, exhibited a complete set of samples of fibrone goods, including inkstands, brushes, switches, rosettes, cut-out boxes, push buttons, switch handles, and all kinds of bases for different electric devices. The samples were of all colors, from a pure white to a jet black, and made, as usual, a very pretty and attractive display.

THE GLOBE CARBON COMPANY, of Cleveland, Ohio, was represented by its general manager, Mr. Chas. Rodman. Mr. Rodman is naturally in good spirits over the increased facilities his company will enjoy after October 1, when they will remove into their new factory at Ravenna, Ohio. This factory has an output of no less than 100,000 carbons per day. Three railroads offer a choice in the matter of shipping, and the company owns land sufficient for a still further increase of the plant if necessary. Mr. Rodman has returned to Cleveland with a number of good orders in his pocket as mementoes of the Convention.

THE CARPENTER ELECTRIC COMPANY, of 620 F street, N. W., Washington, D. C., was ably represented by Mr. Fred Royce. The increased interest in storage-battery traction consequent upon a recent legal decision, gave Mr. Royce an opportunity to expatiate on the superiority of the Carpenter battery. The Carpenter Electric Company are now ready to place their batteries on the market, and will be glad to enter into correspondence with any one who may be interested in the matter.

BIG BELTS FOR ELECTRICAL WORK.

THE largest belt ever made in this part of the country, says the Concord, N. H., *Monitor*, is being prepared for shipment at the shops of the Page Belting Company. It was made for the Reading Electric Light and Power Company, of Reading, Pa., and is 58 inches wide, 127 feet long, and nearly one-half an inch thick, and 140 ox hides were required to make it. The largest ever made before this was 52 inches wide. The belt is securely pegged together and some of the best workmen in the employ of the company were engaged in producing it. With this belt there is also an order for 800 feet of 12-inch double dynamo belt for the same firm.

There have also recently been made by the Page Belting Company two belts 48 inches wide, one 97 feet long and the other 1.› feet long, for the Georgia Electric Light Company, of Atlanta, Ga. These are double and are made in the same manner as the large one first mentioned. Besides these, a recent order has been filled for a belt 26 inches wide and 90 feet long, for the electric lighting station in this city, and eight belts, 20 inches wide, to go on Edison dynamos in Chicago.

LIEB RAILWAY APPLIANCES.

AMONG the more recent specialties produced by the Lieb Machine Works, of this city, are those shown in the accompanying illustrations, Figs. 1 and 2. Fig. 1 shows a line cut-out box, designed

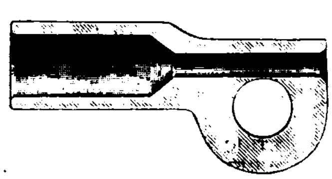


FIG. 2.—LIEB'S CABLE TERMINAL.

to fasten on wood or iron poles. The cover has an endless rubber ring for a packing to keep out moisture, and the safety fuses can readily be replaced. The casing is made all in one iron casting, and the interior mechanism is made of hard brass, all thoroughly insulated.

The cable terminal, Fig. 2, is very substantial, and, for switchboard work, commends itself particularly on account of its strength. These are made of various shapes and sizes. The end of the cable, after removing the insulating material, is introduced into the large hole, which fits over the insulating material, and the naked wires fit the smaller hole and project through, where they they are soldered. The insulating material acts as a cushion, and

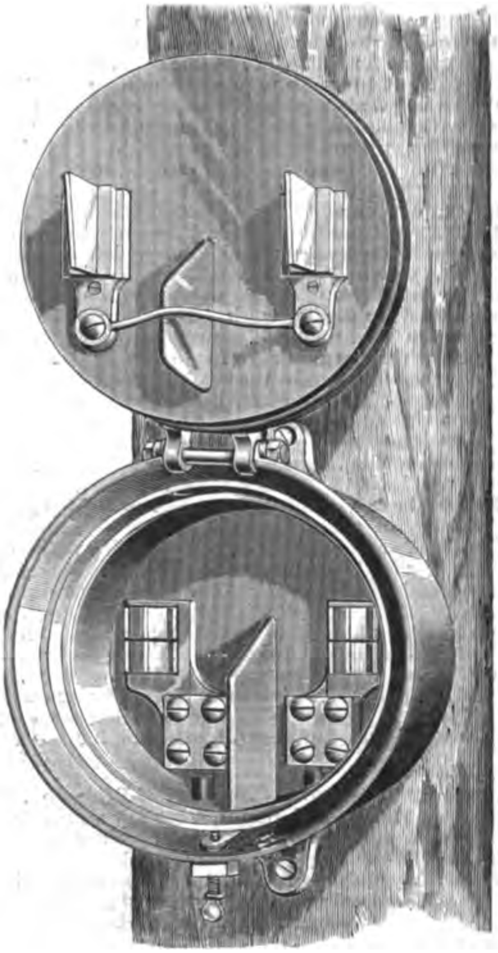


FIG. 1.—LIEB'S RAILWAY LINE CUT-OUT BOX.

prevents the cable from breaking, and, at the same time, protects and hides the end of the insulating material, saving the labor of making a finish between the cable and terminal.

THE ROCKFORD, ILL., ELECTRIC MANUFACTURING CO.

THE above company are installing a 15 h. p. motor in the composing room of the Chicago *Inter-Ocean*, for running type-setting machines. This will probably be the first type-setting machine plant to be operated by electricity in the West. A number of motors, ranging from 7½ to 40 h. p., have been installed in other printing establishments and are giving the utmost satisfaction. The following letter was recently received by the company from the *Inter-Ocean*, and speaks for itself:

"CHICAGO, March 12, 1891.

"ROCKFORD ELECTRIC MFG. CO.,
"Rockford, Ill.

"*Gentlemen*: In reply to your inquiry—and for that matter to the inquiries of many other people—I will say that the Rockford motors, which you sold *The Inter-Ocean* last spring, have given, and are now giving, most excellent satisfaction. All our presses and our stereotyping machinery are run by the motors. We have in all four of fifteen horse-power, and one of seven and a half horse-power. We continue to heartily recommend them to all who make inquiry of us regarding electric machinery. They are simple and easy to manage.

"Very respectfully yours,
"WM. PENN NIXON."

THE BALL ENGINE CO., Erie, Pa., have opened a branch office in Chicago in the Rookery Building, room 506. Mr. Albert Fisher, widely known as a successful salesman, has been appointed manager, and will be glad to see his friends in his new quarters. Mr. Fisher has had a large experience in engines.

THE

Electrical Engineer.

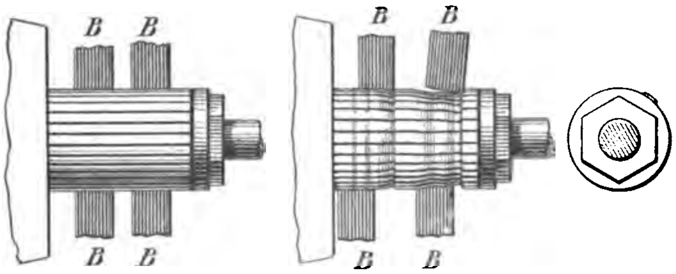
VOL. XII. SEPTEMBER 23, 1891. No. 177.

THE LOCALIZATION AND REMEDY OF TROUBLES IN DYNAMOS OR MOTORS.—II.

BY

Francis B. Crocker and S. S. Wheeler

3. Cause.—*Commutator* (*a*) *rough*, (*b*) *eccentric, or* (*c*) *has one or more "high bars" projecting beyond the others*, or (*d*) one or more flat bars, commonly called "flats," any one of which causes brush to vibrate or to be actually thrown out of contact with commutator. (Figs. 1, 2 and 3.)



FIGS. 1, 2 AND 3.—1. COMMUTATOR IN GOOD CONDITION. 2. COMMUTATOR IN BAD CONDITION. 3. HIGH BAR ON COMMUTATOR.

Symptom.—(*e*) Note whether there is a glaze or polish on the commutator, which shows smooth working; (*f*) touch revolving commutator with tip of finger and the least roughness is perceptible. If the machine runs at high voltage (over 250) the commutator should be touched with a small stick or quill to avoid danger of shock. In the case of an eccentric commutator, careful examination shows a rise and fall of the brush when commutator turns slowly.

REMEDY.—Smooth the commutator with file or fine sandpaper (in latter case be careful to remove sand and *never* use emery), or if commutator is very rough or eccentric, turn it off with a fine cut in a lathe.

In order to have the commutator wear smooth and work well it is desirable to have the armature shaft move freely back and forth about one-sixteenth or an eighth of an inch in the bearings, and the position of the bearings, pulley, collars and shoulders on the shaft and of the machine with respect to the belt should be such as to cause this to take place of itself. (See Heating of Bearings, No. 6.)

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4. Cause.—*Brushes make poor contact with commutator.*

Symptom.—Close examination shows that brushes touch only at one corner, or only in front or behind, or there is dirt on surface of contact.

REMEDY.—File, bend, adjust or clean brushes until they rest evenly on commutator with considerable surface of contact and with sure but light pressure.

(See directions for care of brushes below.)

---

5. Cause.—*Short-circuited coil in armature.*

Symptom.—The particular commutator bar connected to short-circuited coil is burnt by the spark which occurs when brush passes over it.

The short-circuited coil is heated much more than the others, and is very apt to be burnt out entirely; therefore stop machine immediately. If necessary to run machine to locate the short circuit, one or two minutes is long enough, but it may be repeated until the heat of the short-circuited coil is found by touching the armature all over. Considerable power is required to run armature free. An iron screw-driver or other tool held near the revolving armature vibrates perceptibly as short-circuited coil passes. Current pulsates and torque is unequal at different parts of a revolution, these being particularly noticeable when armature turns rather slowly.

REMEDY.—A short circuit is often caused by a piece of solder or other metal getting between the commutator bars or their connections with the armature, and sometimes the insulation between these bars is bridged over by a particle of metal. In any such case the trouble is easily found and corrected. If, however, the short circuit is in the coil itself, the only real cure is to rewind the coil.

In an emergency a short-circuited coil may be temporarily cut out by connecting together the two commutator bars to which its terminals are connected or the two adjacent coils, as described in the Remedy for Sparking, No. 6. But be sure to unwind or open the circuit of the short-circuited coil, as otherwise the trouble will continue.

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6. Cause.—*Broken circuit in armature.*

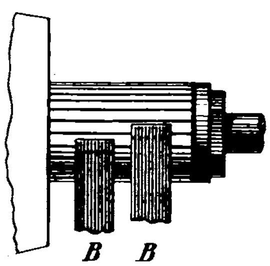


FIG. 4.—STAGGERED BRUSHES.

Symptom.—Commutator flashes violently while running and commutator bar nearest the break is badly cut and burnt, but in this case no particular armature coil will be heated, as in the last case (No. 5), and the flashing will be very much worse, even when turning slowly. This trouble, which might also be confounded with a bad case of "high bar" or eccentricity in commutator (Sparking, No. 3), is distinguished from it by slowly turning the armature, when violent flashing will continue if circuit is broken, but not with eccentric commutator or even with "high bar," unless the latter is very bad, in which case it is easily felt or seen.

REMEDY.—The broken circuit is usually found where armature wires connect with commutator, and not in the coil itself, and the break may be repaired or the loose wire may be resoldered or screwed back in place. If the broken commutator connection cannot be fixed, then connect the disconnected bar to the next by solder, or "stagger" the brushes; that is, put one a little forward and the other back so as to bridge over the break (Fig. 4). If the break is in the coil itself, rewinding is generally the only cure. But this may be remedied temporarily by connecting together by wire or solder the two commutator bars or coil terminals between which the break exists. It is only in an emergency that armature coils should be cut out or commutator bars connected together, or other makeshifts resorted to, but it sometimes avoids a very undesirable stoppage. A very rough, but nevertheless quick and simple way, to connect two commutator bars is to hammer or otherwise force the coppers together across the mica insulation at the end of the commutator. This can be afterwards easily picked out and smoothed over. In carrying out any of these methods care should be taken not to short circuit an armature coil, which would cause Sparking, No. 5.

7. Cause.—*Weak field magnetism.*

Symptom.—Pole-pieces not strongly magnetic when tested with a piece of iron. Point of least sparking is shifted considerably from normal position, due to relatively strong distorting effect of armature magnetism. Speed of a motor is usually high unless magnetism is very weak or nil, in which case a motor may run slow, stop, or even run backwards. A dynamo fails to generate the full E. M. F. or current. The particular cause of trouble may be found as follows: A broken circuit in the field is found by purposely opening the field circuit at some point, taking care to first disconnect armature (by putting wood under the brushes, for example) and to use only one hand to avoid shock, and if there is no spark there must be a broken circuit somewhere. A short circuit is found by measuring the resistance roughly to see if it is very much less than it should be, and usually a short circuit is confined to one magnet and will therefore weaken that particular one most, and a piece of iron held half way between the pole-pieces will be attracted to one more than the other. "Grounding" is practically identical with short circuiting, since one ground would not produce this effect until another occurred, and then we should have a double ground, which is equivalent to a short circuit.

REMEDY.—A broken or a short circuit or a ground is easily repaired if it is external or accessible. If it is internal the only remedy is to rewind the faulty coil.

THE "BI-TELEPHONE."[1]

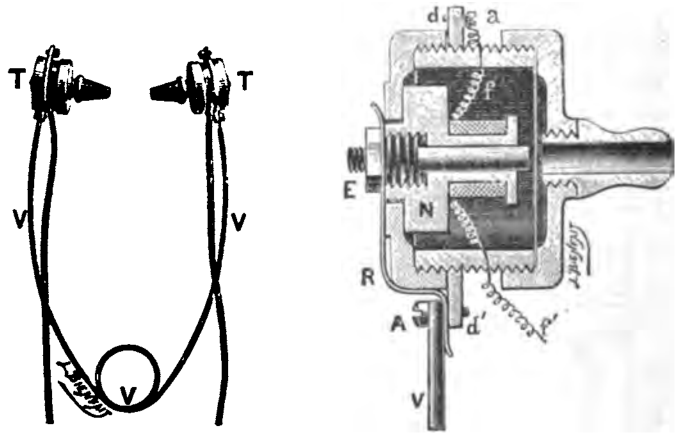
BY E. MERCADIER.

In a telephone which has to serve as a receiver, it is possible to combine clearness in the reproduction of the varied inflections of articulate speech, and the intensity necessary for all the usages of a telephone. For this purpose it is sufficient first to give to the diaphragm of the telephone a thickness just sufficient to absorb all the lines of force of the field of its magnet; second, to diminish the diameter until the fundamentals and harmonics of the enclosed diaphragm are higher than those of the human voice. It will be remembered, moreover, that in satisfying these two conditions, it is possible to obtain with telephones, by means of a very feeble field of force, results comparable in intensity, and superior in clearness, to those obtained with instruments having a field much more intense, and which, in consequence, have a much greater weight and volume.

It follows then that it is possible on the one hand to take very small magnets having two branches, or even one only, as in the earlier Bell telephones, and hence very small bobbins, which permit of a reduction of weight of this part of the telephone in the proportion of one to five; on the other hand, to reduce, as indicated below, the thickness and diameter of the diaphragm. From this there results first a diminution of the size of the box containing the diaphragm, and second, on account of its thinness, the possibility of replacing the metal boxes by those of ebonite, which still further reduce the total weight.

Having had occasion to employ in certain electrical researches, telephones which could act as galvanoscopes, I conceived the idea of utilizing the foregoing results to construct a very light telephone which could remain fixed to the ears for an entire day without fatigue, thus leaving both hands always free.

I have made several types of this kind of instrument, by employing telephones of one or two poles connected by a steel wire spring two millimetres in diameter, shown at V, Fig. 1, which shows, reduced to quarter size, one of these instruments, to which I have given the name of "Bi-telephone." The boxes, T T, are of ebonite, the covers terminating in rubber ear nipples, which may be taken off and



FIGS. 1 AND 2.—MERCADIER'S BI-TELEPHONE.

changed at will (each operator having his own for his personal use), and which extend into the interior of the ear. It is held in place close to the auditory passage, assisted by the light pressure of the spring. These telephones weigh not more than 50 grammes (while those in ordinary use weigh about 400), do not exceed 4 centimetres in diameter, and produce no fatigue or pain after a few minutes' use.

The steel spring connects electrically two of the four ends of the bobbins, so that two flexible cords are sufficient to connect the instrument to the telephone set. The spring may also be magnetized so as to reinforce the magnetism of the telephone cores. It plays, therefore, a triple role—mechanical, electrical, and magnetic.

In spite of the feebleness of its field, the intensity of the effect of this telephone is comparable with that of the instruments in ordinary use, while the clearness is greater. This fact has been established by tests on subterranean lines 50 to 74 kilometres in length, on one telephone line 800 kilometres long, and on the new line between Paris and London, no matter what transmitter was employed.

Fig. 2 shows a section of one of the receivers of a "Bi-telephone" having a rectilinear magnet of the Bell type. The illustration shows the instrument full size. The triple function of the spring V is here clearly shown. The mechanical function results from its form, which tends evidently to exercise a pressure. The magnetic function is exercised through the steel strip R, connecting the spring with the magnetized core N of the electromagnet by means of the screw A and the nut E. Finally the electric function results from one end, *f*, of the bobbin of the electromagnet, being connected with the metallic collar *d d'* by the screw *a*, and thus to the spring V by the screw A.

1. Annales Télégraphiques.

THE FRANKFORT INTERNATIONAL ELECTRICAL EXHIBITION—VIII.

BY

Richard O. Heinrich.

Steam Economizing Devices.

THE importance of the utmost economy in central station work has been pointed out from time to time in THE ELECTRICAL ENGINEER by a number of the most competent engineers in the profession. It may therefore interest central-station managers to give an account of a number of patented devices exhibited by the firm of Klein, Schanzlin & Becker, of Frankenthal, Rheinbaiern.

The water-cooling apparatus, as shown in Fig. 1, will be

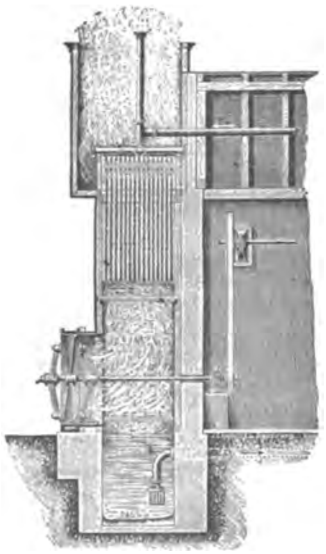


FIG. 1.

of special interest to the designer of central stations, when he has to economize space, and when the water supply for the condensing engines is inadequate. The heated condensing water is lifted to the top of a square tower about 20 feet high. In this tower are vertically suspended a great number of boards about 3½ inches apart. The hot condensing water runs down the boards in a steady, thin surface coating without spraying. A very rapid cooling takes place, favored by the direct air, and by the surface evaporation. The amount of cooling is a very constant factor throughout the year. The cooling by evaporation is great in summer, though the cooling by direct absorption of heat by the air is small; in winter it is just the opposite. To

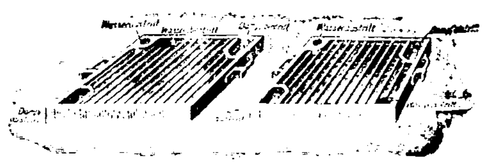


FIG. 2.

increase the cooling effect air is driven upwards against the falling water by means of an electric fan. The cooling capacity is very great; with a fan 6½ inches in diameter, and a tower of 6 x 7 feet in cross-section, 18,000 to 20,000 gallons may be cooled within an hour from 126° F. to 76° F.

The process is almost perfectly continuous, since the evaporated water is always fully supplied by the condensed steam. Another advantage claimed is that the water is almost devoid of air after it has passed the apparatus a number of times, so that it is not difficult to obtain a vacuum of 27.6 inches with the air pump of the condenser. The lubricating oil contained in the water collects at the surface of the water and may be drawn off, the small amount remaining being of advantage for the working of the air-pump.

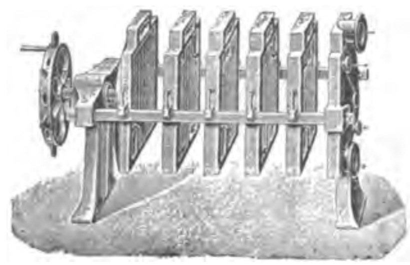


FIG. 3.

Another patented device of this firm, which is to be introduced in America, if the occasion is offered, is the feed-water heater and surface condenser, shown in the accompanying engravings. The cast-iron feed-water heater consists of hollow plates, Fig. 2, which are put together in a frame, as shown in Figs. 3 and 4. The joints between the frame-plates are made tight by pasteboard packing. A large screw at one end of the supporting frame keeps the plates together, and the ease with which they may be separated allows them to be easily and readily cleaned. The inside space of the plates is heated by steam, and the water or fluid to be heated fills the intervening spaces. Numerous ridges, cast on to the plates, cause a quick and complete propagation of heat through the cast-iron. Almost all solid substances contained in the heated water are deposited on the plates, whence they are very easily removed. If the water comes to the heater under low pressure (up to 30 lbs.) rectangular frame-plates are used; if the heater, however, works directly into the boiler with a pressure of from 45 to 105 lbs., the frame-plates are circular, and the packing is laid within a groove.

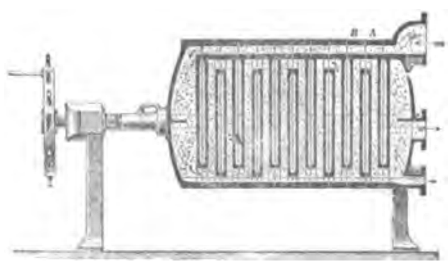


FIG. 4.

In combination with a filter press the feed-water heater is well adapted for the cleaning of the feed-water, Fig. 5. The feed-water is made alkaline by the addition of carbonate of soda. As soon as the temperature of this alkaline water is raised, the lime and magnesia are precipitated, and the water becomes turbid. This water is pressed through the filter part of the apparatus, whence it enters the boiler perfectly clean and pure. The heaters just described may also be used as surface condensers. To prevent leakage of air from the outside into the steam-chest, the whole apparatus is immersed in water. Experiments which have been made with it have shown excellent results.

To dispose of air and condense water together, the firm in question employs the combined wet air and water pump, shown in Fig. 6. At first sight, the connection of the coaxial piston rods, shown in detail in Fig. 7, appears remarkable. The curved connecting piece is made of the best steel. It is evident that the employment of this new and original construction saves considerable space; the fly-wheel comes between the two pistons, and the construction of the machines is greatly simplified.

In such a combined air and water pump the pistons change their up and down motion simultaneously, one beginning to move up as the other begins to move down,

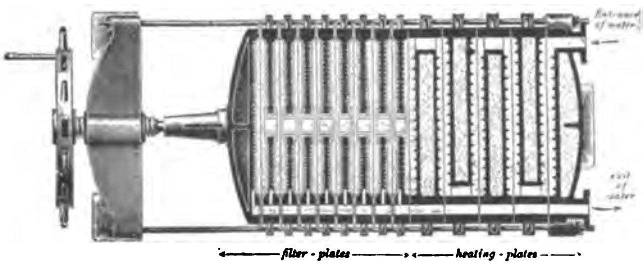


FIG. 5.

and one of the slide-valves opens when the other closes. In this case the two slide-valves may be combined in one, so that the exhaust of the smaller passes from the rear of the combination valve to the larger.

Figs. 8 to 12 show such a combination valve from which of the foregoing description will easily be understood.

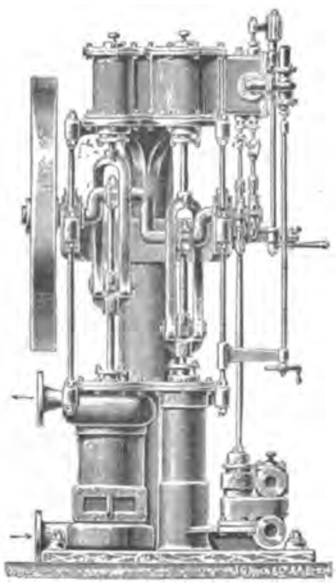
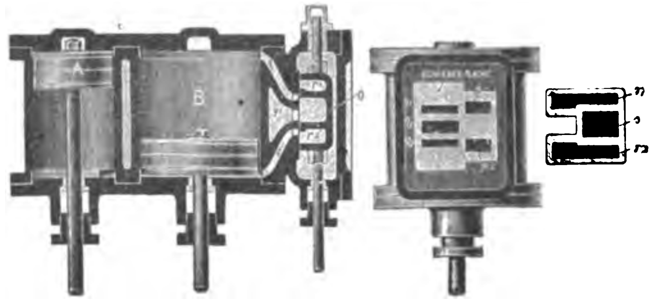


FIG. 6.

Fig. 8 is a section through the steam channels of the large cylinder; Fig. 9, a section through the steam channels of the small cylinder; Fig. 10 shows the sliding-plane of the combination-valve; Fig. 11 shows the combination valve from below, and Fig. 12, a horizontal section through the cylinder and steam channels. In Fig. 8 the smaller piston

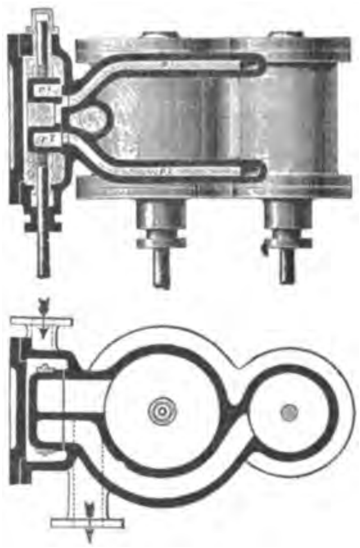
FIG. 7.

begins to move downward, and the larger one upward; therefore, the channel p_1, Fig. 9, receives fresh high-pressure steam, while through channel p_2 high-pressure steam flows into r_2, whence it goes through the opening s, Fig. 8, into the channel q_2 of the larger cylinder, where it acts expansively on the piston of the large cylinder. The exhaust of the large cylinder goes through channel q_1 into the chests of the slide-valve, and the exhaust pipe q_2 into the air. The steam enters the small cylinder simultaneously



FIGS. 8, 10 AND 11.

in two places, half of it through r_1 towards p_1, and the other half directly at p_1. The steam in the channels of the small cylinder expands together with the steam in the



FIGS. 9 AND 12.

cylinder itself into the large cylinder. The long channels of the small cylinder are, therefore, not detrimental, and the channels of the large cylinder are very short.

ELECTROLYTIC SEPARATION OF ZINC.

THE process introduced by M. Neuhausen may be applied to the electrolytic separation of zinc by employing a bath, the temperature of which can be lowered according to the density of current employed. The inventor notices that the temperature must be lowered as the density of current is reduced. The mean of 120 observations is shown in the following table:

Density in amperes	State of metal obtained: 10 deg.	20 deg.	30 deg.	40 deg. Cent.
10	compact	spongy	spongy	spongy
50	—	semi-comp.	—	—
100	—	compact	semi-comp.	—
150	—	—	compact	semi-comp.
200	—	—	—	compact

If it is desired to work with a density of "100 per square metre," the bath, to obtain compact metal, must be kept about 20 deg. C. In commercial practice it is always preferable to use currents of less than 50 amperes density, and to maintain the temperature below 10 deg. C., by means of ice or refrigerating apparatus.

THE IMPORTANCE OF THE POINT OF VIEW FROM WHICH THE TRANSMISSION OF POWER IS REGARDED.

BY

Cary T. Hutchinson

MR. H. WARD LEONARD, a well-known electrical engineer, has published a paper in THE ELECTRICAL ENGINEER for Sept. 2, 1891, which shows forcibly the necessity of looking at every question from all sides before making positive statements, especially if these statements are to be uncomplimentary.

In this paper he, scanning the field from his point of view, the generator, deduces certain formulæ, and then proceeds to berate Mr. F. J. Sprague, who had before this[1] looked over the same ground very carefully from his point of view, the motor; Mr. Leonard, seeing that his side of the shield is silver, cannot conceive that the other side is gold, but insists that it is a base alloy. Mr. Leonard, then goes into detail, and points out with great minuteness just how Mr. Sprague is wrong, and shows marvelous cleverness in giving us the exact logical fault in Mr. Sprague's reasoning, not noticing that the very next moment he employs the same process for the same purpose. Mr. Leonard also strengthens his case very greatly by several misquotations and epithets, such as "no engineer of practical experience," becomes amusingly cynical, and pityingly calls attention to the "beauty of simplicity" of certain laws which he characterizes as "absurd," "erroneous," and which he conclusively proves to be so by referring us to Chart 1 or 2 or 3 (Copyright ! !). A beautiful method of proof !

I purpose showing that Mr. Sprague's formulæ, which Mr. Leonard criticises, are entirely correct, and, moreover, that they are implied in Mr. Leonard's own work; and this implies that Mr. Leonard has unconsciously been calling himself hard names, declaring that he is "no practical engineer," which, coming from so good a source, we are reluctantly forced to believe.

For simplicity's sake, I shall use as far as possible the notation of Mr. Leonard's paper, it being much more accessible than Mr. Sprague's.

Let E, be the P. D. at generator brushes,
e, " " " " motor "
V, " " " " ends of the line,
D, " " " " distance of transmission.

These are the variables; I do not intend going into numerical work, and shall, therefore, simplify the equations by massing constants as much as possible. Calling C the cost of generator and line (bare) per kilowatt at the motor brushes, and assuming that the constants of cost are independent of the voltage, we have:

$$C = a\frac{E}{E-V} + b\frac{D^2}{V(E-V)} \qquad (1)$$

This is Mr. Leonard's equation (7) with the correction of a typographical error and a change in constants; and it is also Mr. Sprague's equation (7), substituting $E - V$ for e and massing constants.

Assuming D constant,

$$\frac{dC}{dV} = a\frac{(E-V)\frac{dE}{dV} - E\left(\frac{dE}{dV}-1\right)}{(E-V)^2} - b D^2 \frac{E + V\frac{dE}{dV} - 2V}{V^2(E-V)^2} \qquad (2)$$

1. Journal of the Franklin Institute, March-April, 1889.

To determine minimum cost this first derivative must be equated to zero, and the conditions for which the minimum is to hold must be carefully defined.

First. From Mr. Sprague's point of view, in which the motor P. D. is assumed constant:

$$E = e + V; \qquad (3)$$

$$\frac{dE}{dV} = 1,\ e \text{ being constant}; \qquad (4)$$

Substituting this value from (4) in (2) and putting (2) = 0,

$$a = b\frac{D^2}{V_0^2};\ \text{or } V_0 = D\sqrt{b/a} \qquad (5)$$

This is equation (10) in Mr. Sprague's paper, and is strictly correct; but the person reading it must have sufficient knowledge to interpret it. Mr. Sprague interprets it faultlessly by saying:—"That is, with fixed conditions of cost and efficiency of apparatus, the number of volts fall to get the minimum cost of plant is a function of the distance alone, and is independent of the electromotive force used at the motor." That is to say, if we wish to use 500 volts at the motor, and with certain coefficients of cost and efficiencies of generator (not of line) the value of $\frac{V_0}{D}$ is ten, then for 1,000 volts at the motor, the value of $\frac{V_0}{D}$ is still ten; and this value of V_0, when substituted in the equation for minimum cost, will, in both cases, give the minimum cost, but this cost will of course be different for the two cases. Putting the value of V_0 from (5) in (1), the minimum cost C_0 is

$$C_0 = a + \frac{2D\sqrt{ab}}{e} \qquad (6)$$

This gives the minimum cost of plant for any motor P. D., when V_0 is given the value demanded by (5); it depends both on the motor P. D. and on the distance.

Second. From Mr. Leonard's point of view, generator P. D. assumed constant:

$$\text{From (3)},\ \frac{dE}{dV} = 0, \qquad (7)$$

when E is constant.

Substituting in (2) and equating to zero,

$$aE - bD^2\frac{E - 2V_1}{V_1^2} = 0 \qquad (8)$$

This is Mr. Leonard's eq. (8) (with correction of another typographical error), and it gives the value which V_1 must have in order that the cost of plant, with any particular value of E and D, may be a minimum; from (8)

$$V_1 = -\frac{bD^2}{aE} + \left\{\frac{bD^2}{a}\left(1 + \frac{bD^2}{aE^2}\right)\right\}^{1/2} \qquad (9)$$

The minimum cost is then, for any P. D. at generator and distance

$$C_1 = a\frac{E}{E-V_1} + b\frac{D^2}{V_1(E-V_1)} \qquad (10)$$

where V_1 has the value given by (9), which is too complicated to substitute.

Putting $V_1 = E\vartheta_1$, or, in general, $V = E\vartheta$, where ϑ is the fractional part lost in the line,

$$C_1 = a\frac{1}{1-\vartheta_1} + \frac{bD^2}{E^2\vartheta_1(1-\vartheta_1)} \qquad (11)$$

Mr. Leonard's Chart 1 can be plotted directly from eq. (11); Chart 2 can be plotted from eqs. (1) and (11), although he gets them in a very much more roundabout way.

Having now shown that Mr. Leonard's equations are substantially the same as Mr. Sprague's, from a different point of view merely, it will prove interesting to show just where Mr. Leonard has strayed. On p. 252 we have:

"By careful (sic !) examination of the paper (Mr. Sprague's) it will be found that after having assumed the value of the E. M. F. at the motor brushes, and the distance also being fixed, the error is made afterwards of considering the results obtained as applicable to cases in which these values are variable." This is, of course, a heinous offense; incomparably worse than assuming the value of the E. M. F. at the generator brushes, and the distance, as fixed, and then varying them in the equation obtained from differentiation; another case of point of view.

To continue: "Now, according to Mr. Sprague, the minimum cost of plant is a function of the distance alone, and is independent of the E. M. F. at the motor;" this is not "according to Mr. Sprague," who has never made such a statement. Mr. Sprague says, "the *number of volts fall* to get the minimum etc."—a very different thing. This erroneous idea pervades Mr. Leonard's mind, and causes him to make a number of curious statements. The numerical example quoted to prove his point has another error in addition to this fundamental one; he says, "With same efficiency of apparatus, that is, 30 per cent loss in condnctor;" even if the "careful examination" of Mr. Sprague's eqnations had not shown Mr. Leonard that the efficiency of the generator was the only efficiency entering the equation, still the exercise of a little mother wit would have shown him that a constant efficiency of line with constant volts drop (for given distance) fixes the value of the motor and generator P. D.; that is, makes it a mere numerical case.

Mr. Leonard next criticises the statement that, "With any fixed couple and commercial efficiency, the cost of the wire should bear a definite and fixed ratio to the cost of the generating plant." This statement in Mr. Sprague's paper lacks one clause, that is, "Under conditions of minimum cost, and with any fixed, etc.;" the meaning is perfectly clear from the equations it is derived from, and any one reading with the slightest care would see it; it is perfectly true, the commercial efficiency being that which gives the minimum cost, corresponding to V_0 of eq. (5). Mr. Leonard attempts to show the absurdity of this by giving numerical examples from Mr. Badt; all these can be explained by keeping in mind the fundamental misconception regarding "volts to get minimum cost" and "minimum cost" itself; but here, as before, Mr. Leonard confuses percentage loss in line and volts drop, making matters much worse.

Again the "beauty of simplicity" of "17.5 volts per thousand feet" is unassailable, provided the numerical work is right; it is not "eminently absurd," and "the transmitter of power who follows these tables" (if conditions implied are met and the arithmetic is correct) will not go astray. Mr. Badt shows himself to be an eminently "practical engineer" by endorsing these statements. One more word and I have finished; quoting Mr. Leonard again, "Mr. Badt, on p. 42, quotes from Mr. Sprague the following misleading rule, etc." Mr. Badt makes no such quotation from Mr. Sprague, nor is there such a rule in Mr. Sprague's paper.

From my point of view the question obtrudes itself, Has Mr. Leonard read Mr. Sprague's paper?

AN ELECTRIC VENTILATOR.

L'Electricité, notices a curious electric ventilator for supplying a building with fresh air, either cold or warmed, as desired. An electric motor sets the ventilator revolving and the revolution sucks cold air in. When warm air is desired, a current is sent into a network of fine wire possessing a high resistance, and through the network the air is obliged to pass: the current heats the wires, and the air necessarily becomes heated. The movement of a switch is sufficient to change the character of the air supplied by the ventilator. This system is capable of considerable adaptation, and it is stated that the hygienic results are uniformly good.

MINIMUM FIRST COST OF PLANT AND MAXIMUM ECONOMY OF OPERATION IN THE ELECTRICAL TRANSMISSION OF POWER.

BY

Chas. J. Reed

In THE ELECTRICAL ENGINEER of September 2, 1891, under the above title, Mr. H. Ward Leonard gives some formulæ, the deduction of which does not seem to me very clear. In equation (2), for instance, is a numerical error which follows through all the other equations. The numerical factor in the denominator should be 15 instead of 7.5, and the equation becomes, $T = \dfrac{D^2 \times K.\ W.}{V(E - V) \times 15}$.

Equations (12) and (13) express a peculiar state of facts, viz., that for any loss between zero and 50 per cent. the cost of conductors increases very rapidly with the loss in transmission! They show also that the cost of conductors depends altogether upon the cost of motors, (G), and the loss in transmission. It seems to me the cost of conductors depends to some extent on the price of copper!

It is not clear that the cost of bare copper and generator are the only elements to be considered in determining the minimum first cost of a plant. It seems to me that the general solution of this problem requires us to consider a number of both dependent and independent variables. In Mr. Leonard's deductions the only independent variable seems to be loss in transmission. This is not in accordance with his preliminary assumption. If it is correct, it ought to make no difference in determining the minimum first cost of a plant, whether we use gold or copper for conductors. There is really no more reason in this assumption then in Mr. Sprague's alleged assumption that distance is the only independent variable. We might as well say the minimum first cost depends only upon the cost of copper, and by assuming all other conditions to be given, derive an entirely different set of formulæ, equally valueless.

The objections raised to Thomson's law are on the assumption that in some cases "*the interest on the plant, even when at its minimum cost, will far exceed the value of the energy wasted.*" If Mr. Leonard can show such a case, we will cure it by simply wasting more energy and using less copper until Thomson's law is satisfied. We shall then find that we have reduced the first cost *below the minimum!*

MINIMUM FIRST COST OF PLANT AND MAXIMUM ECONOMY OF OPERATION IN THE ELECTRICAL TRANSMISSION OF POWER.

BY

H Ward Leonard

MR. CHAS. J. REED has sent to me a copy of his criticism upon my recent article appearing in THE ELECTRICAL ENGINEER under the above title[1] and I beg to make the following comments in regard to his criticisms:

Mr. Reed states that there is a numerical error in equation (2). He states, in effect, that equation (2) gives a value which is double as large as it should be. I find that Mr. Reed has fallen into the error of forgetting that we are dealing with a complete metallic circuit, and that we must provide for a conductor both ways. The formula which Mr. Reed gives would give the correct weight of the copper conductor for the distance D, but, of course, for any

1. See issue of Sept. 2, 1891.

distance of transmission D we must provide a conductor whose total length would be 2 D, so that the equation (2) as given in my article is entirely correct.

The next point Mr. Reed makes is as follows: "Equations (12) and (13) express a peculiar state of facts, viz., that for any loss between zero and 50 per cent. the cost of conductors increases very rapidly with the loss in transmission." Mr. Reed's statement is hardly a correct one. The formula does not apply to any loss between zero and 50 per cent., but to any loss which is the proper loss for conditions of minimum total first cost of plant. By examination of Chart 1 we find that, at the same distance, the greater the percentage of loss in the line, the higher the price of conductors. While this appears paradoxical, it is due to the fact that the initial volts, which at any distance make the smaller loss that of minimum first cost, are very much higher than the initial volts which at the same distance make the greater percentage of loss correspond to the minimum conditions. Formulæ (12) and (13) do not state, that for any given initial E. M. F. at any given distance the cost of conductors increases very rapidly with the loss in transmission, which Mr. Reed has apparently assumed to be the case. Mr. Reed states that these formulæ appear incorrect because they are independent of the price of copper. This is in reality not surprising when it is remembered that we are not considering the general case of the cost of conductors, but that we are considering that cost of conductors which corresponds to the minimum total first cost of plant. Under these latter conditions, it is entirely true that the amount which must be invested in the conductor is independent of the price per pound.

Mr. Reed states that it is not clear that the cost of bare copper and generator are the only elements to be considered in determining the minimum first cost of the plant. Theoretically speaking, he is correct, but, practically speaking, these two items are the only ones worthy of notice, and such other items as the labor in stringing the lines, etc., are not only extremely small in amount, but they do not, under any fixed conditions of loss in transmission and cost in materials, vary in proportion to the amount of power transmitted, nor do they conform to any fixed law which can be followed mathematically. It is evident that the cost of stringing a conductor ten times the size of a second one is not ten times the cost of stringing the second one. If, by making the necessary complicated assumptions and deductions, we inject such insignificant factors into the problem it is evident that our loss in transmission in order to conform to minimum for cost conditions, would have to vary for every different amount of power transmitted, and that we would introduce a serious error, instead of gaining any additional accuracy.

Mr. Reed states that, according to my deductions, "It ought to make no difference, in determining the minimum first cost of the plant, whether we use gold or copper for conductors." This is entirely correct, that is, the laws governing the conditions of minimum first cost are the same if we use a material for the conductor of a certain conductivity entirely regardless of its price. This is, of course, entirely different from the statement that the first cost will be the same whether gold or copper be used, which interpretation Mr. Reed has apparently placed upon it.

Mr. Reed's last point is as follows: "The objections raised to Thomson's law are on the assumption that in some cases '*the interest on the plant, even when at its minimum cost, will far exceed the value of the energy wasted.*' If Mr. Leonard can show such a case, we will cure it by simply wasting more energy and using less copper until Thomson's law is satisfied. We shall then find that we have reduced the first cost *below the minimum!*"

In reply to this, let us suppose that the interest and depreciation upon our plant is \$9 per annum per kilowatt delivered; also, that the value of one kilowatt is \$5 per annum; so that under conditions of 15 per cent. loss in transmission, the value of the energy wasted is 75 cents per annum. In order to make the interest and depreciation equal to the value of the energy wasted, it will become necessary, in following Mr. Reed's suggestion, to increase the loss. As we increase the loss in the conductor, it is evident that we are increasing the cost of the generator capacity required for every kilowatt transmitted; and it is this very point, namely, the increase in the cost of the generator with every increase of loss in the conductor, which makes Thomson's law inapplicable, and Mr. Reed seems not to have followed this point to which my article calls special attention.

By reference to Chart 3 it will be found that the fourth curve from the top, at the left., is the curve of interest and depreciation at 15 per cent. per annum; the lowest curve on the chart is that of the value of the energy wasted in the conductor per annum when one kilowatt at brushes is worth \$5 per annum. In order to apply Thomson's law, it would be necessary to project these two curves to a point where they cross, which they never will, and even within the range of the chart it is evident that both values are rapidly increasing and any attempt to make the two values equal by further increasing the energy wasted, is evidently leading further from the minimum value, and not toward it. The minimum value, under the conditions given, will be at 15 per cent. loss, as is indicated by the third curve from the top, which expresses the maximum economy in operation when the interest and depreciation is 15 per cent., and one kilowatt per annum is worth \$5; but instead of these two values being equal under conditions of maximum economy, the interest and depreciation is found to be more than ten times as large as the value of the energy wasted.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—XV.

BY

Chas. Steinmetz.

HAVING produced this *curve of induced* E. M. F., or "TRANSFORMER-CHARACTERISTIC" we determine the correct curve of *eddy-currents.*

The eddy-currents are proportional to the magnetization, hence proportional to I, and, if the variability of the magnetic susceptibility is taken into consideration, the curve of the eddy-currents, or rather of their M. M. F., will be no longer the straight line G^1, used in the diagrams, Figs. 5 and 6, but a curve, g, Figs. 27 and 28, which is proportional to the curve of induction, i.

In Figs. 27 and 28, the horizontal distance, $\overline{FG}$ of g from $f = \overline{OF}$, represents the M. M. F. of eddy-currents, corresponding to the resulting M. M. F., $F = \overline{OF}$, $\overline{FG}$ being proportional to $\overline{FI}$. Hence we only need to determine the M. M. F. of the eddy-currents for one particular resulting M. M. F., $\overline{OF}$, which gives us one point of the curve, g, to be able to produce the whole curve, g, by means of the proportionality of $\overline{FG}$ with $\overline{FI}$.

The *hysteretic curve*, or curve of the ideal M. M. F. representing the loss of energy caused by hysteresis, can be derived in a similar way. The loss of energy by hysteresis was represented in the diagram by the product, $E_1 \times H^1$, where E_1 is the induced E. M. F., H^1 the ideal hysteretic current.

This hysteretic loss I found, as before said, to be proportional to the 1.6th power of the magnetization; that is, other things being equal, proportional to the 1.6th power of the induced E. M. F., E_1 or I. Hence the ideal hysteretic current H^1, and therefore its ideal M. M. F., H, is proportional to the .6th power of the induced E. M. F.. $I = \overline{FI}$, corresponding to the resulting M. M. F., $F = \overline{OF}$.

Thus we only need to determine the hysteretic loss for one particular M. M. F., F, compute therefrom the ideal M. M. F. of hysteresis H for this particular resulting M. M. F., F, and produce $\overline{FH} = H$ horizontally from F, to get one point of the hysteretic curve h (Fig. 27 and 28).

Then by means of the proportionality of $\overline{FH}$ with the .6th power of $\overline{FI}$, we derive the complete and correct curve of hysteresis. At the same time, this gives us means to separate the loss of energy due to hysteresis, from the loss caused by eddy-currents.

For, determining the whole loss of energy in the iron, hysteresis and eddy-currents for two different M. M. F.'s, $\overline{OF_1} = F_1$, and $\overline{OF_2} = F_2$, calculating therefrom the ideal current and the ideal M. M. F., $\overline{FK} = K$, representing hysteresis and eddies combined, we derive, from the two equations,

$$\overline{F_1K_1} = \overline{F_1H_1} + \overline{F_1G_1} = \varepsilon\, I_1^{.6} + \beta\, I_1$$
$$\overline{F_2K_2} = \overline{F_2H_2} + \overline{F_2G_2} = \varepsilon\, I_2^{.6} + \beta\, I_2$$

the coefficient ε of the ideal M. M. F. of hysteresis H, and the coefficient β of the M. M. F. of eddy-currents, G.

Having so determined the curve of *ideal* M. M. F. *of hysteresis*, h, and the curve of M. M. F. *of eddy-currents*, g, in their dependence upon the resulting M. M. F., F, we produce the curve of *impressed* M. M. F., k, by adding both curves, h and g, together, so that $\overline{FK} = \overline{FH} + \overline{FG}$.

This curve k is the curve of *magnetic lag*, α, and of the *primary* M. M. F., L^{∞} *at open secondary circuit.*

Now, after we produced the curves, i, h, g, k, we can proceed to the construction of the *complete transformer diagram.*

Suppose the transformer has in the primary and in the secondary coil the same *number of turns*, $n = n_1 = 40$. The *secondary* E. M. F. may be, $E_1 = 73.8$ volts maximum value, the *secondary resistance*, $r_1 = 2$ ohms. Hence the *secondary current* will be, $C_1 = 36.9$ amperes, and the *secondary* M. M. F., $L_1 = 1476$ ampere turns.

We then make, in the diagram, Fig. 27, $\overline{OE_1} = E_1 = 73.8$ volts, and erect in E_1 a perpendicular line upon $\overline{OE_1}$, which intersects the transformer characteristic, i, in the point I.

Through I we draw a horizontal line which intersects $\overline{Of}$ in F. Hence $\overline{OF} = F$ is the *resulting* M. M. F., necessary to induce the *secondary* E. M. F., E_1.

Continuing $\overline{IF}$, until it intersects the curve k in K, $\overline{FK}$ gives the *ideal* M. M. F. *of hysteresis and eddy-currents combined*, $\overline{FH}$ *the ideal* M. M. F. *of hysteresis*, $\overline{FG}$ *the* M. M. F. *of eddy-currents.* $\overline{OK} = K$ is the *impressed* M. M. F.

Completing the parallelogram of M. M. F.'s $\overline{OL_1}$, $\overline{KL}$, that is, producing $\overline{KL} = \overline{OL_1}$ horizontally from K, $L = \overline{OL}$ is the *primary* M. M. F.

Carrying out this construction of L for different secondary E. M. F.'s, E_1, or for different resulting M. M. F.'s, F, we derive l, the complete *curve of primary* M. M. F., L, corresponding to the secondary resistance, $r_1 = 2$ ohms.

In the usual way, the primary M. M. F., L gives us the *primary current* C, and the *primary resulting, or heating* E. M. F., E, for different magnetizations, but the same secondary resistance, traveling on the curve, e. Primary resulting E. M. F., E, and primary induced E. M. F., $E_1 = E_1$, give, by the parallelogram of primary E. M. F.'s, $\overline{OE_1}$ $\overline{EE_0}$ the *primary impressed* E. M. F., E_0, traveling on the curve, e_0.

OZOKERITE.

The principal ozokerite mines are situated in Galicia, the produce being about 200 tons per week. It is estimated that about half this quantity goes to Russia, where it is used in the manufacture of ceresine candles for churches.

DYNAMO PULLEYS AND BELTING AT THE FRANKFORT ELECTRICAL EXPOSITION.

BY

Chas. A. Schieren

An electrician or engineer is generally so much absorbed in the mechanical construction of the dynamo that he gives the belt only a passing glance; at least this has been my conclusion from observation and experience at the International Electrical Exposition now being held in Frankfort, Germany; hardly one person out of ten would notice the belts at all, as they passed by the various dynamos and machinery exhibited there. All engineers, however, will readily admit that the belt plays an important part in the satisfactory and successful running of the dynamo.

The special correspondent of The Electrical Engineer, Mr. Richard O. Heinrich, in his excellent reports has not yet mentioned anything of the belting exhibited here. I will therefore give a brief sketch of the leather belting on exhibition and in operation here, which may be of interest to some of your readers.

In a small, out-of-the-way building, set apart for "Maschienen Bestandtheile," I find eight firms exhibiting belting; it can hardly be called "International," because outside of the fine display of leather link belting made by the American Leather Link Belt Co., of New York, no foreign firm is represented. The remaining exhibits are of German manufacture, and consist principally of the usual European heavy, thick belt, stitched with alum-tanned lace leather; some have six or more rows of this stitching in one width of belt. One creditable exhibit, which shows considerable progress in point of quality and finish, and also excellent workmanship, is that of Klinge Bros., of Dresden, Saxony.

As a rule, the belts intended fór dynamos are made single, and most of them are very uneven, with the stretcher marks left on the joints (the most vital part of the belt), and these belts cannot run satisfactorily on a dynamo; they must necessarily be unreliable and slip badly when in operation. Many devices for making belts endless are also exhibited, some as crude and heavy as they can possibly be made. One of these, in the shape of a hinge intended for a four-inch belt, weighs half a pound. The lace leather exhibited is generally good, and much like ours in the United States.

Messrs. Schark & Co., of Mayence, exhibit pulleys covered with small pieces of leather, strung together with lacing edgewise, then cemented on the face of the pulley and turned off very smoothly. It makes a fine covering, but very expensive, and is of doubtful durability. The same device, except that a thin, flat steel plate is used, was recently patented in America; however, the German patent is an improvement.

Evidently the German belt-makers are not restricted as to the length of pieces put into belting, and very sensibly cut the pieces of leather according to the quality of the hide. The ridiculous notion has been introduced in America, especially among electric light people, that the length of pieces should be only four feet four inches, as if hides could be grown to order; it naturally necessitates a great waste of material. Messrs. Kaulhausen & Son, of Aachen, exhibit a bungling imitation of the well-known "Perforated Electric Belt." The device is a sort of nickel-in-the-slot affair, consisting of rows of long, narrow slots put irregularly in the belt.

Of the belts in operation in Machinery Hall I will have something to say later, several machines not being ready. However, from the leather belting exhibit made by the Germans, it is evident they are not up to the demands of the present progressive age, and the American manufacturers lead them in many ways.

THE DETROIT ELECTRICAL WORKS NEW STREET CAR GEARS AND CARBON BRUSH-HOLDER.

RECENT improvements introduced by the Detroit Electrical Works on their electric railway system are worthy of attention as they indicate a decided step in advance in the operation of electric cars. As our readers are aware, in this company's system the power is transmitted from the motor to the axles through the medium of a pair of beveled gears. Heretofore these gears have been of the usual type, cut very accurately on a special machine, and under the general conditions of service left little to be desired in smoothness of operation and as regards wear; but in climbing heavy grades, and where severe loads are brought upon the gears, some difficulty was encountered due to the fact that one set of teeth, after some wear, would sink too far into those of the other, which in some instances led to the fracture of the teeth. This difficulty has now been entirely avoided and at the same time the cost of the gears largely reduced by the type of shrouded bevel gear just adopted, and which is now in successful operation on the Rae cars at Aurora, Ill., and Lawrence, Mass.

The accompanying illustration, Fig. 1, will give a good idea of the new type of gear. It will be noted that at each end of the teeth the rim is left plain, one-half the teeth projecting above the rim and the other half being sunk below it. It will thus be evident that under no circumstances can the relative depth of mesh of one gear with the other vary in the slightest degree, the two plain surfaces at the end of each gear forming a bearing which limits the depth of mesh under all conditions. In addition to the increased life obtained by this form of gear, it also permits of the use of wheels just as they come from the casting mould, and they require no finishing whatever of the teeth; in fact, these are now cast with almost perfectly round surfaces, and the results already obtained would seem to indicate that a valuable improvement in electric railway work has been inaugurated by the application of the shrouded gear. Another interesting improvement brought out by the Detroit Electrical Works is the carbon brush-

FIG. 1.—DETROIT ELECTRICAL WORKS NEW CAR GEARS.

holder, applicable both to railway and to stationary motor and dynamo purposes of all kinds. Recognizing the difficulties encountered with bolts and nuts which work loose, especially in railway service, the company have brought out a brush-holder in which no device whatever of this kind is employed, the brushes being controlled entirely by a spring arranged in an ingenious manner so that its tension can be regulated at will.

The accompanying engraving, Fig. 2, shows the brush-holder, the left-hand brush being shown under tension, effected by means of the spring with a loop at the top. The tension of this spring is regulated by means of a pin controlled by a lever, which has a pawl attached to it and which meshes with the ratchet shown, the spring being coiled around the pawl pin. By merely raising this lever so as to disengage the pawl from the ratchet-teeth and sliding it forward or backward, the tension can be regulated to a nicety, and the pressure of the carbon upon the commutator is thus effected with precision. When it is desired to remove or replace the carbon, the spring can be pulled down, and, by means of the loose ring, held in the position shown at the right-hand brush-holder, which leaves a perfectly clear space for the insertion or removal of the carbon. The spring where it bears against the carbon is re-enforced by a strip of brass so that it is well able to stand the slight frictional wear brought upon it during the process of altering the tension. The brush-holder, it will be noted, is made in

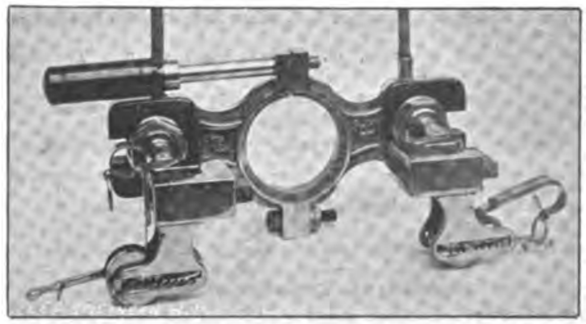


FIG. 2.—DETROIT ELECTRICAL WORKS BRUSH HOLDER.

two sections, which are bolted together at their lower end, and are held together, and at the same time clamped, by the long clamping bolt, provided with an insulating handle.

This brush holder was exhibited by Mr. Ch. A. Benton at the New York State Street Railway Convention, held in this city last week, and elicited much favorable comment from the electric railway men present.

AN ENORMOUS MICROSCOPE.

THE Poeller Physical Optical Institute of Munich have under construction an enormous microscope for exhibition at Chicago in 1893. It will magnify to 16,000 diameters, or, as ordinarily fitted, to 11,000 diameters. An electric light of 11,000 c. p. is to be used for illuminating the image, which is to be projected on a screen. As the heat from this powerful light would derange the focus by expansion of the metal, an ingenious cooling device is used. This consists of a small copper cylinder filled with liquid carbonic acid under a pressure of 350 lbs. to the square inch. It is connected with the microscope in such a manner that an electric regulator automatically opens a valve and allows a drop of the acid to escape in a spray on the metal to be cooled; the liquid immediately evaporates and produces intense cold. The whole cost of the instrument is said to be nearly $10,000.

THE ELECTRIC UTILIZATION OF WATER-POWER IN BAVARIA.

A COMPANY has been formed in Lindau under the name of the Elektricitätswerk der Argau for the purpose of supplying Lindau, Langenargen, Friedrichshafen Tettnang, Ravensburg, Weingarten and Wangen with electric light and power. At a meeting recently held, Herr Huber, of the Maschinen Fabrik Oerlikon, recommended the adoption of the rotary current. About 3,000 h. p. will be available for distribution. It is estimated that the yearly charge for 1 h. p. will not exceed $30 or $35, and that lamps will cost about $5 per annum.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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Nature is our kindest friend and best critic in experimental science, if we only allow her intimations to fall unbiased on our minds.—Faraday.

ARC LAMP TRIMMING.

FOR some reason the very important item of recarboning, or, as it is technically called, "trimming", arc lamps has not been much discussed either in the electrical press or at meetings and conventions bearing on the subject. This cannot be because it does not need such discussion, as those at all familiar with the work are aware that it does, and that badly.

The satisfactory working of the lamp depends largely on the trimming, and if this is indifferent or poor, so likewise will be the light. Not only will customers growl, but extra expense will grow out of repairs thus made necessary. Trimmers are usually of a class who will be careless unless held rigidly to their work, as tested by close inspection. Rods not well cleaned will become covered with blotches or specks from poor contact in the works. They will stick and cause the lamp to flame and otherwise burn badly, and often burn out magnets. This can be caused only in two ways, carelessness and too long a route for the trimmer. If carbons are placed crooked or are not of proper length, one of the holders is sure to be burned and destroyed—if the lamp lights at all. Many stations buy "seconds" of carbons because they are cheap, but it is in some cases doubtful if the cost of destruction of carbon holders is not in excess of the difference of price, not to mention the extra time used in trimming. The time does not enter largely into the calculation, as routes are usually laid out so that the work is done some time before lighting up, and if an especially bad or crooked lot of carbons is struck, part of this period is available.

These are only a few of the troubles that could be mentioned. The question of size and style of carbon also demands some attention, but this can usually be settled best by the persons in charge of the plant, if good judgment is employed. The use of plain or copper-coated is largely a matter of opinion, but is more or less governed by the location of the lamp. Whether to use all of one length or in pairs, *i. e.*, one 12 inch and one 7 inch must also be decided by those in charge, as it is controlled by the length of time of burning of the lamps. It is found in practice that for all ordinary work on 0 ampere current lamps, a copper-coated ½ inch carbon 12 inches long answers the most generally. For double lamps, one carbon broken in the middle will answer all purposes. In all cases trimmers should be compelled to bring in a carbon stump for every one used. In many places where such a system has been tried the saving in carbons has been very large. In discussing the cost of trimming lamps we find that no attention is generally given to the location and distance apart or length of route. It will readily be seen that this is an important item and should be made a part of the factor of cost. It has been suggested that the cost of trimming per lamp-foot might properly be used as a unit—that is, the number of lamps multiplied by the distance traveled in feet would be the basis of laying out a route. There is so little difference of time required for one system as compared with another, that it need not enter into the discussion at all. In the large cities where lamps are close together, many more can be trimmed than in a country place where they are widely spread. For instance, it has been found that 85 or 90 lamps can be well trimmed by one trimmer in New York city, and in cases of extra good workman, a hundred or more. We have heard of one place where lamps were run away out into the country and all the farms and parks lighted up. In this case 40 lamps were a big day's work for the best trimmer. Therefore, when a man says that his trimming costs two cents or two and a half or three cents a lamp, and another that his costs four or five cents, they hardly meet on a common basis for figuring costs; whereas, if they both use the unit of lamp foot, neither has the advantage and a proper comparison can be made at once.

Of course, all costs will be governed by the price of labor in the different localities, but this will not change the comparison in any way.

The whole subject will bear wide discussion, and there is scarcely another item in the entire field of arc lighting which is more vital to the good working and growth of the business, and consequently the satisfaction of customers.

THE EXPENDITURES OF AMERICAN CITIES.

"UNTIL our American cities demonstrate their capacity to do a few things well, it would seem to be clearly unwise to enlarge their inherent powers upon the theory that because they have not done a little well, they still would be able to do a great deal well." Thus President Seth Low, of Columbia College, in an article in the September *Century* on the government of cities in the United States. He says, moreover, that no business within the city could be successfully managed by the bodies to whom has been committed the management of city affairs. And yet in face of facts so self-evident that every newspaper in the country is full of them and depends on them for its most sensational headlines, we are told that the next thing in the line of civic and municipal development is the setting up of city electric light plants. A special committee at Haverhill, Mass., for example, has just reported as the result of its investigations that the first and only conclusion to be drawn from a study of certain figures it has accumulated is that cities can furnish their own electric lighting more cheaply and advantageously than it can be procured from private parties. What utter nonsense this is. Half the figures are lies, to begin with, and as to the inference on the whole of them, we will simply quote Mr. Low again, with the reminder that he was once mayor of Brooklyn. As to "the question whether a city should or should not manufacture its own gas, and either build or conduct its own street railroads, * * * the city surely is fortunate which is competent to do things of this sort for itself; but few American cities have manifested so great competency in other directions as to justify a very strong inference that they would administer successfully business of this kind."

MECHANICAL AND STEAM APPLIANCES AT THE FRANKFORT EXHIBITION.

ALTHOUGH professedly devoted exclusively to electricity, the Frankfort Exhibition, being one designed to illustrate the present state of electrical engineering, of necessity gives occasion for the display of numerous accessory apparatus employed in connection with nearly every electrical plant. The belts exhibited, of which Mr. Ch. A. Schieren gives an interesting expert account, would hardly seem to compare favorably with those of American manufacture, but on the other hand one must not lose sight of the fact that the electric light has been a most potent factor in the perfection reached by our belt makers, an influence which has until within a short period been lacking in Germany, and on the continent generally. The acknowledged superior quality of American belting illustrates once more the direct influence of a new art on another older one. The steam appliances at the Frankfort Exhibition described by our correspondent, Prof. Heinrich, will also be of interest to station managers, especially those who have to contend with impure water for boiler purposes.

THE TELPHERAGE INTERFERENCE.

A DECISION which happens to be of unusual importance in its relations to electrical interests was rendered by Commissioner of Patents Simonds, on September 12th, in the interference case of Hunter v. Jenkin. The particular subject-matter in issue was the well-known system of automatic electrical transportation, invented and patented some years since by the late Fleeming Jenkin and termed by him "telpherage." The immediate importance of the decision is due to the circumstance that it is virtually a test case, involving substantially the state of facts, and the same proofs as a very large number of other cases which have been some time pending in the Patent Office, in behalf of the same contestant, covering not only most of the fundamental principles, but a large number of absolutely essential details of the construction and operation of electric railroads. The decision of the new Commissioner is not only of interest to the many inventors and attorneys engaged in the cases referred to, but possesses no small intrinsic value as an able, exhaustive and accurate statement of the doctrine of our patent law with reference to the frequently recurring question of diligence on the part of the party first to conceive, in a contest for priority of invention before the tribunal of the Patent Office. It once more places the legal position of the Office in harmony with that which has been uniformly held by the Federal courts, the marked divergence from which in some recent instances has given occasion for much unfavorable comment among parties having cases pending before that tribunal.

THE ADVANCE OF ELECTRIC RAILROADING.

THE meeting of the New York State Street Railway Association last week was almost wholly devoted to electricity, and that with the more significance that just outside of its hall were the new tracks of the Broadway cable road—one of the wildest pieces of folly that this generation of New Yorkers has seen. Splendidly built as the road is, one can but see in it the evidence of poor judgment and expensive short-sightedness. It is as though a man had invested heavily in fine stage coaches at the moment when steam locomotion had begun to make its triumphant demonstration. The paper by the incoming president, Mr. Beckley, of Rochester, was enough to show which way the tide was running, for admitting all the defects of the electrical method, he was still compelled to advocate it as that which, par excellence, is the best for nearly every large community in the United States. The proof of the pudding is in the eating. Three years ago there were a dozen operative electric roads in this country. To-day there are 375, with another hundred getting ready for work.

Composite Electric Light Stations.

THAT the days of the "one system" stations are passed and gone was forcibly brought out in the address of President Huntley, and the paper read by Mr. H. Ward Leonard at the Convention served to show in what manner the operation of the composite station could be carried on in the most economical way. Mr. Leonard, it will be noted, started out with the proposition of solving two distinct problems in electrical distribution, namely, the overcoming of distance and of low economy in operation. If a single station is to surmount both these bars to commercial success, it must be so organized that the apparatus to be employed at any one time must operate at its highest economy at that particular time, and with the variable load which we know to exist to-day on electrical distribution circuits, it requires not a little ingenuity to work out such a system. The plan suggested by Mr. Leonard seems to be quite a feasible one and certainly possesses the advantage that it affords a means of obtaining current for every possible purpose with the apparatus at command to-day.

THOMSON'S CONSTANT CURRENT TRANSFORMER.

In an interesting letter appearing in The Electrical Engineer of July 1, 1891, Prof. Elihu Thomson drew attention to a new type of constant-current transformer invented by him several years ago, but of which the full details could not be made public owing to the peculiar position in which American inventors, applying for foreign patents, are placed. The recent issuance of the patent referred to by Prof. Thomson enables us now to give a more detailed description of this interesting machine, which is illustrated in the engraving, Fig. 1.

As pointed out by Prof. Thomson at the time, the machine was designed and constructed for use in systems of distribution with continuous currents, being a continuous-current transformer compounded for drop in the machine itself, for drop in the secondary, and for drop in the high potential or main line leading to the machine. The machine also admits of ready compounding for the combined drop.

The diagram, Fig. 2, illustrates the method of operation of the system. The generator G feeds a system of mains, m m', which branch into subsidiary mains, n n' n^2 n^3. The armature is divided into two sections, A A'. The core A has a winding which is connected in the ordinary manner with

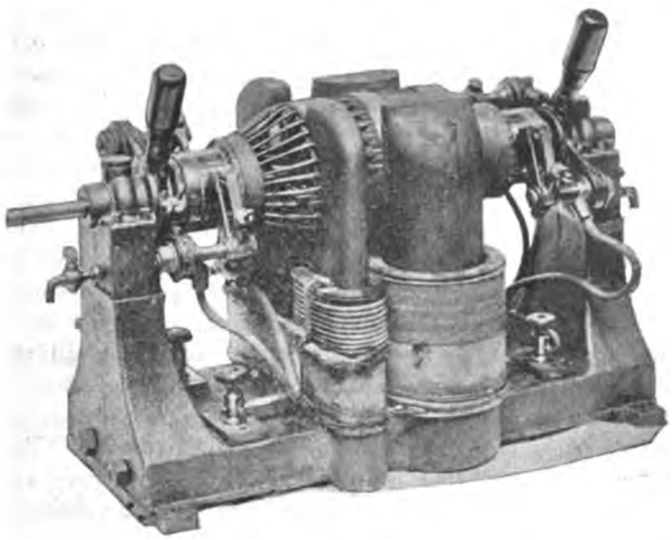


Fig. 1.—Thomson Constant Current Transformer.

the commutator C, and the combined sections A A' have a winding which covers both, and the terminals of which are connected to the commutator C'. In the left-hand transformer, Fig. 2 it will be seen that the commutator C takes current from the sub-main n n', and that the magnets affecting the section of armature A are shown as wound with fine wire coils, S S', and are energized in shunt. They are therefore of fairly constant magnetism, except for drops of potential in the line. It will also be seen that the connections from the brushes resting on the commutator C', which is the local-circuit commutator, are carried through and around coils D D, which affect a separate set of field-poles acting on the armature-section A' alone. The local circuit passing through the magnet-coils D D', then passes to the lights or other load which are fed by it. This arrangement may, however, be modified, as shown in the right-hand transformer, Fig. 2. Here the coils D D' are traversed by the current in the sub-mains n^2 n^3, which practically become the path of a direct current passing through the commutator C', while the local mains and commutator are connected directly without intervention of any coil between them. This is seen to the right hand of the figure, where the work circuit L is fed direct from the commutator by a connection to its brushes, while the shunt S S' is worked, as before, in derivation from the sub-mains n^2 n^3.

Now, assuming that the winding on the armature has been properly done, so as to give whatever reduction of potential is required when the load is light, as when there are no lamps burning at L, then this relation will have to

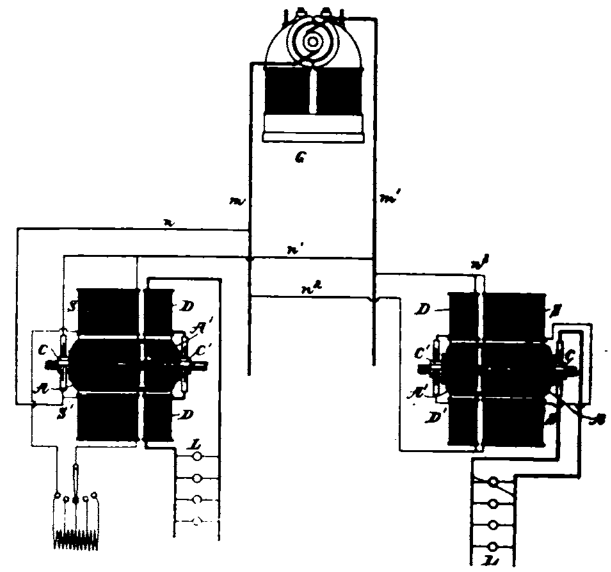
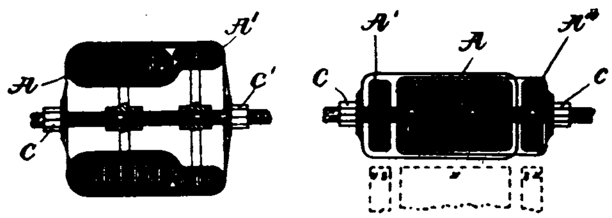


Fig. 2.

be changed whenever the load is thrown on in consequence of a drop which occurs not only in the machine, but in the local mains and in the feeding mains n n'. It is to compensate for this drop that the accessory portion of the armature A' and the winding which is upon it come into play. As lights are turned on, the current which flows in the local circuit in the transformer, Fig. 2, will evidently increase, and the coils D D' will therefore be able to magnetize their cores and affect the armature-core A' and the coils which correspond—that is, the potential will be raised in the local circuit when the magnetism of the cores D D' is added to that of the shunt-coils S S'—and tends to enhance the value of the local coil on the armature. This enhanced value is obtained without affecting the value of the other armature-winding, which is connected to the commutator C. The effect would be then equivalent to an increase of the effective length of the local circuit armature-winding, while maintaining the high potential or main-circuit armature winding the same. The power to be given to the added field coils and the added armature-section A' will depend upon the amount of this increase required to compensate for the drop, and is a matter to be determined in each particular case.

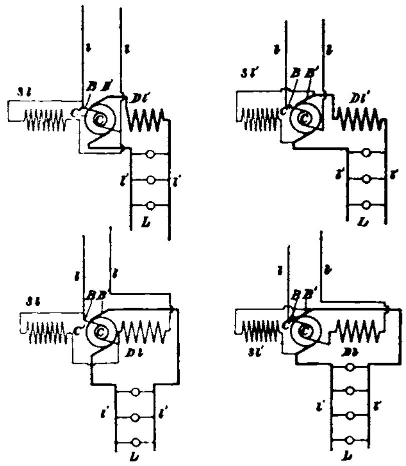


Figs. 3 and 4.

Fig. 3 shows a ring-core, the winding of the main body of the core being connected to the commutator C. Alongside of it is a similar ring-core, A', which is wound over with another winding connected to the commutator C'. This armature has the same properties as the armature shown in Fig. 2, and may be used in a similar field.

In Fig. 4 an arrangement is shown in which there are three sections of armature. The winding overlaps two of them in each case; but the winding connected to the commutator C overlaps the section A' and A, while the winding connected to the commutator C′ overlaps the section A A². In this case three sections of the field-pole are used—N, N S, and S N—the outer smaller poles being made alternately south and north, respectively, and in the desired direction for the two windings, so as to increase or diminish the effect of one with respect to the other, as the need arises.

Fig. 5 shows a circuit connection in which the shunt-winding is a connection taken out at S *l*, taken from the feeding-main *l l* in shunt to the brushes of the commutator C, which corresponds to one winding on the armature, while the commutator C′ is the one which feeds the local mains,



FIGS. 5, 6, 7 AND 8.

and the direct circuit D *l′* or direct magnet is placed in this circuit, feeding the lights L and the local mains *l′ l′*.

Figs. 6, 7, and 8 show other modifications, which will be readily understood.

THE "VULCA" ELECTRICAL WIRE DUCTS.

OF the improvements constantly going on in the electrical arts at the present time, none are more pronounced than those which pertain to the methods of wiring and the distribution of conductors for general service in the streets, as well as in the interiors of buildings. The attainment of the highest safety, especially in house wiring, is being brought out more and more prominently and insisted upon by the various boards of fire underwriters, so that it is to be hoped that the time will soon come when the badly installed electric wiring plant will be as little tolerated as a leaking gas pipe system. To attain this high standard of house

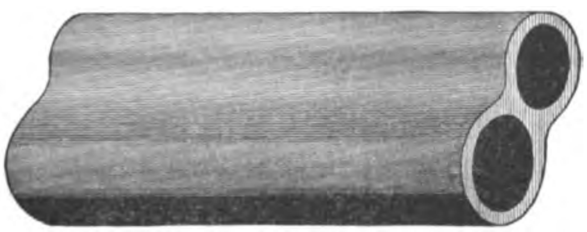


FIG. 1.—DUPLEX VULCA DUCT.

wiring, it has been recognized that wires require to be laid in passages or conduits especially provided for that purpose, and one of the latest efforts in this direction is that embodied in the system now placed before the public by the New York Insulated Wire Company and known as the "Vulca" electrical wire ducts. The aim of the manufacturers of this tube has been to supply a non-inflammable and moisture-proof tube, which should at the same time have a high tensile strength and which should not collapse when placed in wet mortar, cement or plaster, a property which is evidently a *sine qua non* of a tube designed for application below the surfaces of walls. At the same time the tube must be of such a nature as to permit of the easy insertion and withdrawal of wires, and for that purpose the "Vulca" ducts are made with a smooth and hard surface, both within and without.

These tubes, when used singly, are made in sizes of from ¼ to 1¼ inch inside diameter, and when used double or duplex, as shown in Fig. 1, vary from ¼ to ½ inch in diameter. Besides the tubes, the system has been worked out completely as regards its accessories, and a full set of elbows, right-angles and S-offsets for all sizes have been designed. In running these tubes the joints are

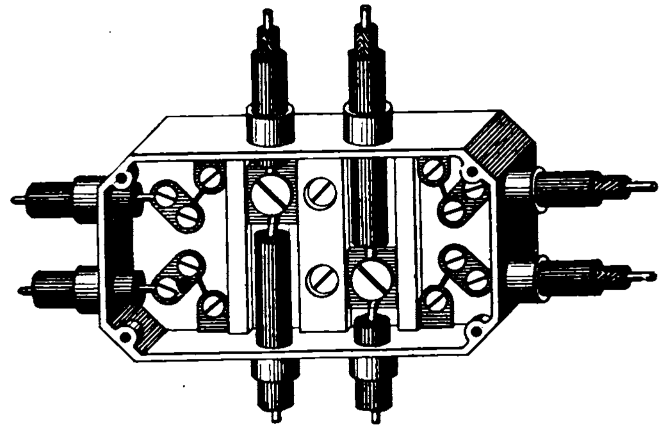


FIG. 2.—2-WIRE DOUBLE BRANCH CUT-OUT.

made by squaring the ends of the tubes and slipping them into a brass tube, one conduit tube abutting against the other. Over all this there are wrapped two layers of pure rubber, making the joint absolutely moisture-proof and the insulation at that point equal to that of the rest of the tube. The company advocate the insertion of only one wire in each tube and that wire covered with a high-grade insulation. For convenience sake, however, it is

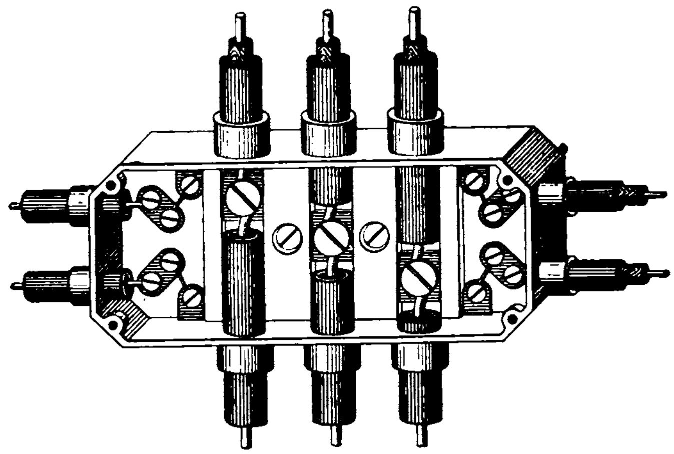


FIG. 3.—3-WIRE DOUBLE BRANCH CUT-OUT.

frequently desirable to use the "duplex" tube and all the appliances are also made for this tube.

Among the distributing boxes employed with the "Vulca" ducts are the single and double branch cut-outs for the two and three wire systems, shown in Figs. 2 and 3; while the straight-away cut-out and fishing-box is shown in Fig. 4. Figs. 5 and 6 show respectively the single-branch cut-out and the angle boxes

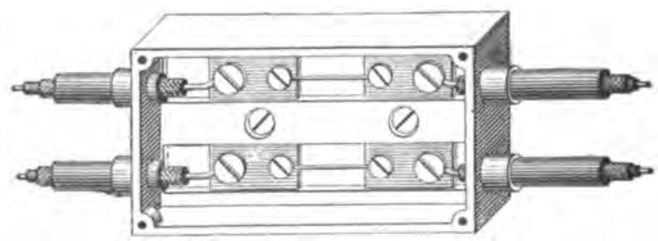


FIG. 4.—STRAIGHT-AWAY CUT-OUT AND FISHING BOX.

for fishing and turning corners. All these appliances are mounted on porcelain bases and inserted in boxes fitted with sockets for the entrance of the tubes, the diameter of the sockets being slightly smaller than those of the tubes, so that the tube, when forced in, makes a moisture-proof joint. The company advocate shortening the length of the tap circuits as much as possible and placing the cut-out boxes as near as possible to the lights, and hence they prefer to place the boxes at the baseboard near the floor, as shown in Fig. 7, or under the

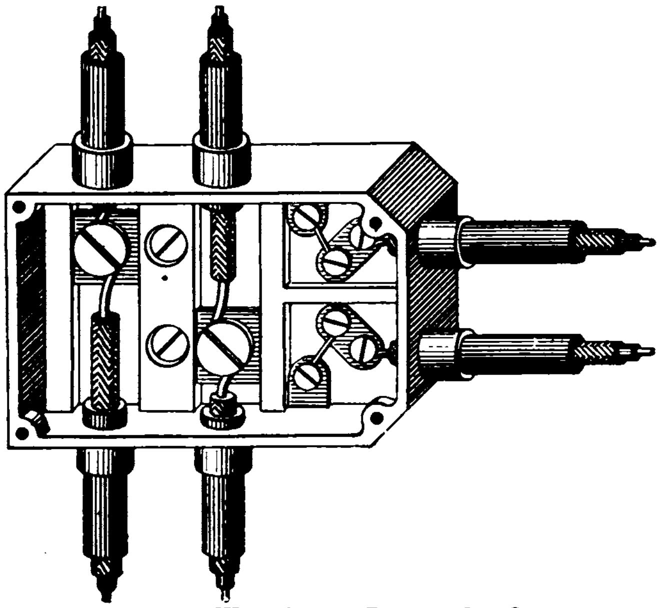


FIG. 5.—2-WIRE SINGLE BRANCH CUT-OUT.

cornice, as shown in Fig. 8. For vertical mains or risers their practice is to place all the boxes in recesses in the wall and to

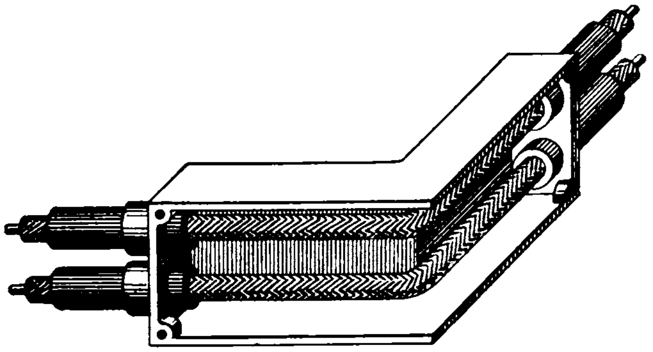


FIG. 6.—ANGLE BOX FOR FISHING AND TURNING CORNERS.

have at each floor a main-floor cut-out, as shown in Fig. 9, from which all the wires start out that feed the circuits on that floor.

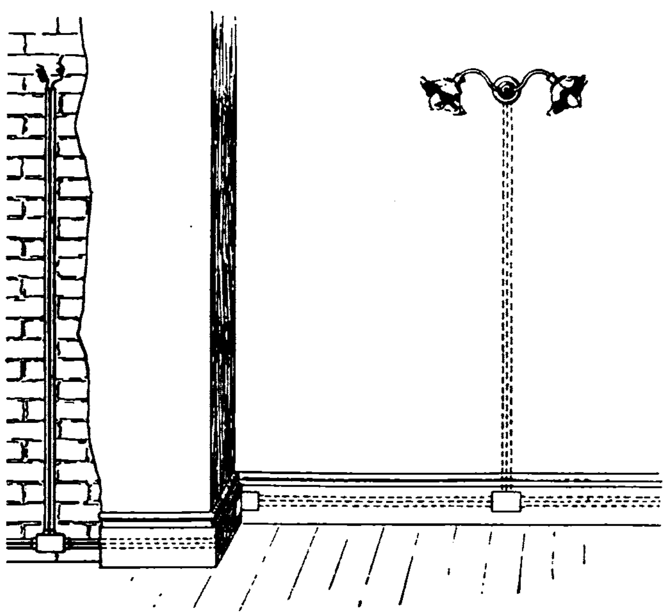


FIG. 7.—VULCA DUCTS BEHIND BASE-BOARD AT FLOOR.

The recess is provided with a removable cover, so as to be accessible at all times.

The material of which the "Vulca" tubes are made possesses, it is claimed, a rare combination of qualities; thus while, as above stated, it is moisture-proof and non-inflammable, it can be drilled, tapped, filed and threaded, being about as tough as good, hard wood. It can also be used with safety where the ceiling and side walls are to be decorated, as it will not exude or stain; hence, it can be placed directly in cement or plaster without any outside protection, such as a metal tube. Where it is used for surface work it can be polished like hard rubber and can be japanned and stained to match any wood-work. The duplex tube can also serve as a very convenient picture rod. The method of fastening the tube to rough walls is also very simple. For this purpose a nail is driven in and the tube fastened with wire twisted around the nail.

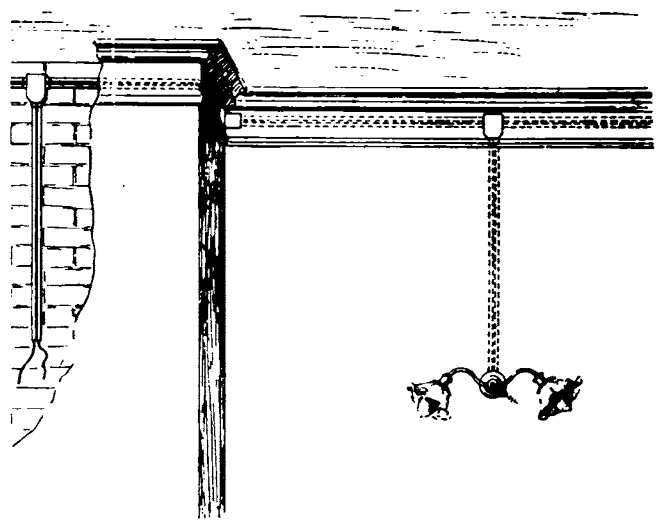


FIG. 8.—VULCA DUCTS BEHIND CORNICE AT CEILING.

At the Electrical Exhibition just held at Montreal, under the auspices of the National Electric Light Association, a full line of samples of these tubes was exhibited, stained in imitation of all the favorite decorative woods, such as ash, black walnut, mahogany and oak, as well as bronzed and silvered. The New York Insulated Wire Company, the well-known manufacturers of the

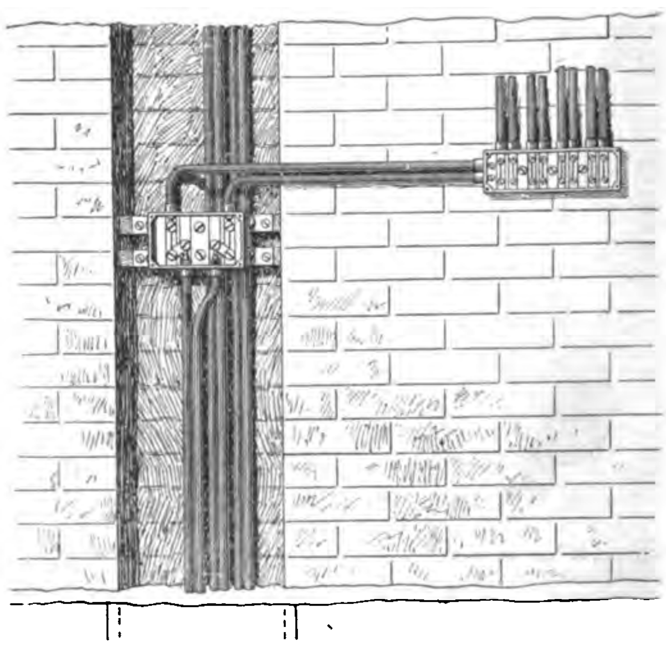


FIG. 9.—MAIN FLOOR CUT-OUT.

Grimshaw wires and cables, are now thoroughly prepared to furnish these tubes in any quantity, and their many excellent qualities will no doubt soon create a large demand for them.

MR. C. E. HUGHES, manager of the Western Union office at St. Paul, Minn., has resigned.

MEETING OF THE STREET RAILWAY ASSOCIATION OF NEW YORK.

THE Ninth Annual Meeting of the Street Railway Association of the State of New York was held at the Hotel Metropole, New York City, on Tuesday, September, 15, 1891. President Daniel F. Lewis called the meeting to order.

The following delegates were present:

Beckley, John N., pres. Rochester Railway Co., Rochester.
Beers, Edwin, pres. Broadway Railroad Co., Brooklyn.
Calhoun, John M., pres. Forty-second St. and Grand St. Ferry R. R. Co., N. Y. City.
Cannon, Duncan B., sec. Brooklyn City and Newtown R. R. Co., Brooklyn.
Curtiss, Frank, pres. Sixth Avenue Railroad Co., N. Y. City.
Delancey, Wm. H., supt. North and East River R. R. Co., N. Y. City.
Field, C. J., engineer Buffalo Railway Co., Buffalo.
Foster, John S., pres. Forty-second St. M. & St. N. Ave. Ry. Co., N. Y. City.
Graham, Benjamin, vice pres. Rochester Railway Co., Rochester.
Hasbrouck, Daniel B., sec. Houston, West St. and P. F. R. R. Co., N. Y. City.
Kruesi, John, pres. Schenectady Railway Co., Schenectady.
Landon, E. T., auditor Dry Dock, E. B. and B. R. R. Co., N. Y. City.
Law, George, pres. Eighth Avenue Railroad Co., N. Y. City.
Lewis, Daniel F., pres. Brooklyn City Railroad Co., Brooklyn.
Linch, George W., sec. Christopher and 10th St. R. R. Co., N. Y. City.
Littell, H. H., pres. The Cross-Town Railroad Co., Buffalo.
McIntyre, L. H., supt. Harlem Bridge M. & F. Ry. N. Y. City.
McLean Thos. H. sec. Twenty-third Street Railway Co., N. Y. City.
McNamara, John W., pres. Albany Railway Co., Albany.
Masson, Milton I., sec. Central Cross-Town Railroad Co., N. Y. City.
Minary, C. K., gen. manager Rochester Railway Co., Rochester.
Partridge, John N., pres. Brooklyn City and Newtown R. R. Co., Brooklyn.
Richardson, W. J., sec. Atlantic Avenue Railroad Co., Brooklyn.
Scribner, G. Hilton, pres. Central Park, N. & E. R. R. R. Co., N. Y. City.
Thompson, Henry, pres Broadway Railroad Co., N. Y. City.
Valentine, Johnson L., treas. Central Park N. & E. R. R. R. Co., N. Y. City.
Watson, Henry M., pres. Buffalo Railroad Co., Buffalo.
Wyman, C. Densmore, vice-pres. Central Park, N. & E. R. R. R. Co., N. Y. City.

There were also present the following street railway officials:

Barr, Thomas C., pres People's Passenger Railway Co., Philadelphia, Pa.
Lawless, Edward J., supt. Paterson Railway, Paterson, N. J.
Perrine, Lewis, pres. Trenton Horse Railroad Co., Trenton, N. J.

The street railway and electrical press were represented, as follows:

T. C. Martin, THE ELECTRICAL ENGINEER.
C. E. Stump, C. B. Fairchild and J. H. McGraw, *Street Railway Journal.*
F. L. Kenfield, *Street Railway Review.*
P. G. Monroe, *Street Railway Gazette.*
E. V. Cavell, *Street Railway News.*
Charles W. Price, *Electrical Review.*
E. V. Cavell, *Electrical Age.*

MR. G. GREEN, the proprietor of the Metropole, being an old street railway president, constituted himself the host. The session was opened by President D. F. Lewis, who made a pithy and pertinent address on the general situation, referring hopefully to electricity, and emphasizing the need of closer union among street railway men. The report of the Executive Committee also touched upon electric power as "surely the most brilliant and magnetic, the loftiest and most promising." Mr. J. Beckley, of the Rochester, N. Y., city railway, then presented an admirable report on the use of electric motive power for street railways. In the course of his remarks, he said:

"Five years ago the only street surface railways which were in successful operation anywhere in the United States were horse and cable railways. Within that five years more than 4,000 street cars have been electrically equipped, and to-day more than 3,000 miles of track in 300 cities and towns in this country have been constructed on which these electric cars are run with satisfaction to the people, and, in the main, with profit to the companies operating them.

"The development of the street railway has had as much to do with the growth and prosperity of the towns and cities of this country as, or perhaps, more than, any other thing. The transportation of people by street railroads is most intimately connected with the social and business life of the people. Nearly 500 cities in the United States have street railway systems in operation. More than 800 corporations are operating street railways in such towns and cities. As many as 30,000 street cars, horse, cable and electric, are to-day running upon the 8,000 miles of street railroads in this country. In these cars, and on these tracks, are carried as many as 3,000,000,000 of people yearly, or fifty times the entire population of the United States. When we consider that the number of people carried by all of the steam railroad companies in all of the States of this Union last year is estimated at less than 500,000,000, and that more people are carried on the street surface railroads in the city of New York in a year, than are carried by all the steam railroads of the State in the same period, we come to have some conception of the immense importance to the people of the rapid, efficient and safe service of street cars in the rapidly growing cities and towns of this wonderfully prosperous country. Think for a moment of the daily loss to the people of any city where horse cars are run at from four to six miles an hour, as compared with the operation in the same city of electric or cable cars, running from six to twelve miles an hour. Consider the immense increase in the value of property in our municipality, caused by the introduction of rapid transit. Consider the wholesome influence upon the people of every community where the husband, or other head of a household, is able, by means of facilities of quick transportation, to take his midday meal with the members of his family. The best thought of this time may well be expended upon this great question of furnishing quick, safe, cheap and comfortable transportation to the people whose lot it is to dwell, as dwell they do in such vast numbers, in the towns and cities of this land.

"The problem which is presented to the street railroad man of to-day must be considered, not simply with reference to the populations as they now exist, but with reference to the great increase of population, which is certain to come There are seventy-four cities in the United States which have a population in excess of 40,000. The total population of these seventy-four cities, as shown by the last census, is nearly 13,000,000, and the average increase of population in these cities during the last decade is nearly forty-seven per cent. In this State there are twenty-eight cities having a population in excess of 10,000, and a total aggregate population of nearly 3,500,000. The average increase in population of these cities, in the past ten years, has been more than thirty-three per cent. For all these growing towns and cities in our own State, and throughout the country, what can electricity do as a motive power for the operation of their street railroads?

"We who have had to do somewhat with the change of the system of operation of street surface railroads from horse to electric power, know that we have now passed beyond the experimental stage, and are beginning to tread upon ground which seems firm under foot. We hear, now and then, fears expressed by doubting Thomases as to whether the motors are going to last, as to whether the repair bill is not going to wipe out all profit, and as to whether the great expenditure which has been, and is being made on our railroads, may not be thrown away, because some new and wonderful principle is to be discovered which will enable our railroad companies to operate their roads with commercial success by means of storage batteries. We find in some communities so great a prejudice against overhead wires that railroad companies are unable to obtain the necessary franchises and privileges, the granting of which would result in giving those communities the benefits of rapid transit with electricity as motive power. Hour by hour, however, experience is teaching all doubters that the problem of rapid transit for cities has been solved, and that the trolley has come, and come to stay."

After complaining of the inadequacy of Mr. Cooley's recent census figures on street railway work, Mr. Beckley said:

"The company which has had the greatest experience as to these matters is the West End Street Railway Co., of Boston. That company has published a statement showing its earnings and expenses both with the electric and the horse car system, for the months of April, May and June of this year. I ought perhaps to state that, as it seems to me, the conditions involved in the consideration of these questions are so diverse in different cities that the only proper basis of comparison of cost of operation is the cost per car mile. It is quite common for the street railroad officials to consider this question of the relative cost of operation upon the basis of a percentage of gross receipts. It will be readily seen, however, that this basis of comparison is necessarily misleading and inaccurate. The other basis is not exact, but approaches at least approximately to exactness. The total expense, as shown by the West End company, for motive power, car repairs, damages, wages of conductors and drivers, and all other expenses per mile run with electric power, during the three months mentioned, was as follows:

April	21.75 cents.
May	22.36 "
June	20.37 "

The total expense per mile run with horse power, for the time mentioned, was as follows:

April	24.54 cents.
May	24.04 "
June	23.52 "

"Earnings upon the two lines, during the period under consideration, with the two systems, were as follows:

April—Electric	....34.05 cents.	Horse	....31.77 cents.
May—	" ...33.43 "	"	....34.22 "
June—	" ....42.71 "	"	....36.85 "

"It will be observed that the earning power of the electric cars is considerably in excess of that of the horse cars, and that the expense per car mile is considerably below. The West End company states that the electric cars of this company are run on the longer and less remunerative lines. If this be true, the showing made is very greatly in favor of the electric car from a commercial standpoint.

"Permit me to refer to the experience of the company at Rochester, with which I am connected. In the month of May last, the Rochester Railway Co. operated 44 18-foot vestibule electric cars. The gross receipts from passengers riding on these cars during the month was $37,053, or 23.15 cents per car mile for a mileage of 159,567 miles. The total expense of operation of these cars for that month was $18,332, thus leaving a net profit of $18,721. The total cost of operation per car mile was 11.4 cents, and the profit per car mile was therefore 12.11 cents. It may be observed in passing that the operating expense was a trifle under 50 per cent. of the gross receipts.

"The cost of operation was divided as follow:

Motive Power	2.8 cents.
Car repairs	.7 "
Conductors and motormen	4.9 "
Other expenses	3

"During the same period the company operated 62 horse cars, all of them without conductors. Most of the horse cars were one-horse or bobtail cars. The total cost of operating the horse cars, without conductors, during this period was about ten cents per car mile, but the total receipts per car mile were but little above twelve cents.

"In the month of June the Rochester Railway Co. operated 54 electric cars and 60 horse cars. The electric cars earned each per day $23.60, or 22.77 cents per car mile, and the total expense of operating them per day was $10.50, or 11.07 cents per car mile. The cost of operation per car mile was divided as follows:

Motive power	2.40 cents.
Car repairs	1. "
Conductors and motormen	5 66 "
Other expenses	2.01 "
Making a total per car mile of	11.07 cents.

"The cost of operating the horse cars during the same month per car mile was 11.06 cents, and they earned 14.37 cents per car mile. These illustrations are fairly indicative of our experience in Rochester month by month. My experience in the operation of street railroads has convinced me that the most economical system of operation is the electric system. I have not, in the statements which I have now made, taken into consideration the greater fixed charge in the operation of an electric railroad as compared with a horse railroad, due to the much greater cost of the former; but in arriving at the conclusion which I have above expressed due consideration has been given to this one of increased cost. We know that when a horse railroad is changed over and operated by electricity, the receipts are very largely increased. It is safe in any case to say that the increase in gross receipts will be at least 15 per cent., and the average increase is probably as high as 30 per cent. Some of this increase is undoubtedly due to the greater mileage which the cars make, and still more is due to the cleaner, more rapid and more comfortable transportation of the people.

"We have reached the conclusion also that the bugaboo, which formerly somewhat frightened us, of the cost of maintenance and renewals of electric motors, need frighten us no longer. We have had motors in constant service on one of the first electric lines equipped in this country, namely, the line extending from Rochester to Charlotte, and these motors seem as efficient and in every way as satisfactory as they did the first month they were operated. We have, of course, renewed various parts of the motors, and we have replaced gears which have worn out, the expense of which has gone into the cost of maintenance. But the motors are still there, doing their work, and likely, with proper care and renewal of parts, to be doing their work ten and even twenty years, from to-day. The cost of maintenance and renewal of parts has not been so large as to carry operating expenses up to anywhere near the expense of operating the same number of cars, at the same mileage, by animal or cable power.

"Those who propose to substitute electric for horse-power will make a great blunder if they attempt to put in cheap construction or material. We who have gone into this matter have learned that the track upon which it is proposed to operate electric cars should be of girder or T rail, of not less weight than fifty pounds to the yard of T, and sixty-two pounds to the yard of girder rail. The weakest place in the track is, of course, at the joint, and no cheap contrivance at that point should on any account be permitted. With girder or T rail construction it is, it seems to me, a useless expense to lay a continuous supplementary wire. The rails should, of course, be well and heavily bonded at the joints with iron, not copper, wire and cross-connection of rails be frequently made. Where tram rail track is used, I think a continuous wire should be laid and connected with the bond wires.

"The overhead wire cannot be too well put up. Cheap devices should never be used because they are cheap. The best and strongest are none too good. In putting up the feed wire and putting in the ground wire return to the generators, do not spare copper. I am convinced that much that we have heard about the inefficiency of generators and motors is due to trying to get too great a quantity of current through too small a quantity of copper. In the power station do not make the units too large. Accidents will happen as long as machinery is run, and an accident to a 500 h. p. plant is serious, while you can keep your cars or most of them moving, if one of two or three small engines breaks down. The same rule, of course, holds as to the generators.

"Always put in a condensing steam plant. One large item of expense of operation is the coal bill. Cut that down at least forty per cent. by erecting condensing engines. The first cost is, of course, a little more, but your stockholders, as they examine your statements of operation in the years to come, will say you were wise in your day and generation.

"Locate your power station as near as may be in the centre of your system, but above all, if possible, on a stream large enough to furnish all the water you require for the boilers and condensers. City water, where your consumption runs into the millions of gallons fast, is expensive.

"It seems to me a mistake to equip a car body of greater length than eighteen feet, and I think a sixteen-foot car is better still. During the hours of the day when travel is heavy, it is easy to pull a trailer, and when traffic is light, you are then not using up your power in hauling around a great, lumbering double-truck structure practically empty."

The president having called upon electric railway representatives for some remarks

MR. CHARLES A. BENTON, representing the Rae system of the Detroit Electrical Works, addressed the delegates briefly. The system, he said, was unique. They manufactured a single motor made in three sizes, 15, 30 and 40 h. p. The peculiar advantage claimed for the system is that it gives to both axles a traction on the rails, which cannot be got by any other system. While the system was one of the most recent in the field, it had a respectable record, and while others might need a corps of expert electricians, it would do its work steadily with only the help of a single blacksmith.

MR. C. C. CURTIS, of the Short Company, said: "When this Convention met in Rochester last September, the Short Company came before you and made some very strong promises as to the showing that would be made when the road in Rochester was started. What that showing has been you have heard in the very able report that has just been read. The question in which you are all vitally interested is the question of repairs; repairs to your motors, repairs to your lines, and repairs to your generators. In the city of Rochester there has been kept day by day an accurate record of the motor and generator repairs. That road started running last November; and giving it eight months of run through the winter months—the hardest months in the year—up to the first day of August, the average cost of repairs per car mile was four mills. This is a very fine showing, as I think every gentleman who has kept a similar record will admit. The report just made gives the total repair account. That repair account as given month by month by Mr. Beckley, will, of course. include the repairs of the line, generators, motors, rail, etc. When I say four mills per car mile, I mean only the repairs on the generators and the repairs on the motors; that is, the electrical repairs. In Muskegon, Mich., where we have been running about a year and a half, our record shows two mills per car mile. We have two new motors to offer to you. We are prepared to give you the double-reduction motor or the single-reduction motor, and the low-reduction motor. You know how great and excessive the repairs on gears are. One of the gentlemen who was on the floor of this Convention stated to me a month ago, that in his judgment, if our gearless motor was really what we claimed for it (and we are prepared to back up our claim with strong guarantees) it would save his company seventy-five per cent. of the repair account. If this is true, no road should be equipped without looking carefully into the merits of this Short gearless motor. I have a report of a test made in Cleveland, Ohio, about two weeks ago, by Mr. Al. Johnson, with whom, no doubt, many of you are acquainted. It was a trial between one of his cars and one of the Short gearless motor cars. These two cars ran over the Brooklyn street railroad line, running about twenty minutes apart, doing commercial work. The gearless car checked up some eighty passengers, and the single reduction motor, which Johnson was running, checked up forty-seven. The car ran for about two hours and a half, and we have the half-minute readings. The report and the readings show that the single-reduction motor takes twenty-four per cent. more current than the gearless motor."

MR. M. K. BOWEN then described the Short generator recently described in THE ELECTRICAL ENGINEER.

MR. G. W. MANSFIELD spoke very forcibly and eloquently on the work done by the Thomson-Houston Co., whose roads were now to be found all over the world. After referring to troubles from snow, he introduced

MR. BARR, of the same company, who described their new snow-sweeper, which is equipped with a broom fitted with flat steel blades and flat steel wire brushes. The blade does the major part of the work, and will actually cut ice. The steel brush does the rest of the work. This "broom" runs at 150 turns a minute.

MR. H. W. GRANNIS described briefly the Westinghouse railway motors and methods, especially the gearless type of car. In the first year of their work, they had installed their motors successfully on about 70 different roads.

MR. C. J. FIELD, of the Field Engineering Co., insisted on the necessity of good construction work in electric railway plants.

MR. C. D. SHAIN made a very brief and business-like statement in behalf of the Edison General Electric Co.

MR. C. C. BOWEN described the plans of the Multiple Distributing Station Electric Railway Co., which proposes to feed into the railway circuit from block to block, as the car progresses, by special devices, the remainder of the line being "open."

The recommendation of the Executive Committee that the By-Laws be amended so that companies whose annual gross receipts from passengers are less than one hundred thousand dollars may be admitted to membership upon the payment of nominal annual dues, viz., five dollars, was adopted.

The following officers were elected for the ensuing year: President, John N. Beckley, Rochester; First Vice-President, Thomas H. McLean, New York City; Second Vice-President, George Law, New York City; Secretary and Treasurer, W. J. Richardson, Brooklyn.

Executive Committee.

President and Secretary, Daniel F. Lewis, Brooklyn; G. Densmore Wyman, New York City; Charles Cleminshaw, Troy.

Saratoga Springs, N. Y., was selected as the place for the next meeting of the Association, which will take place on the third Tuesday in September, 1892.

The meeting then adjourned.

All in attendance at the Convention were photographed in a group in front of the hotel just before luncheon. After luncheon, the party, as the guests of the retiring President, Mr. Daniel F. Lewis, went for a drive through Central Park and along the Riverside drive to High Bridge and Ft. George.

In the evening Mr. George Green, proprietor of the Hotel Metropole, tendered a complimentary banquet to the Association, to which all in attendance at the Convention were invited. About fifty gentlemen composed the party. It was of an entirely informal nature, although everything necessary to make the occasion thoroughly enjoyable was bountifully provided.

There was some brief speech-making indulged in, and shortly before nine o'clock the gathering dispersed.

THE BRUSH ELECTRIC CO.'S NEW DYNAMO AND MOTOR.

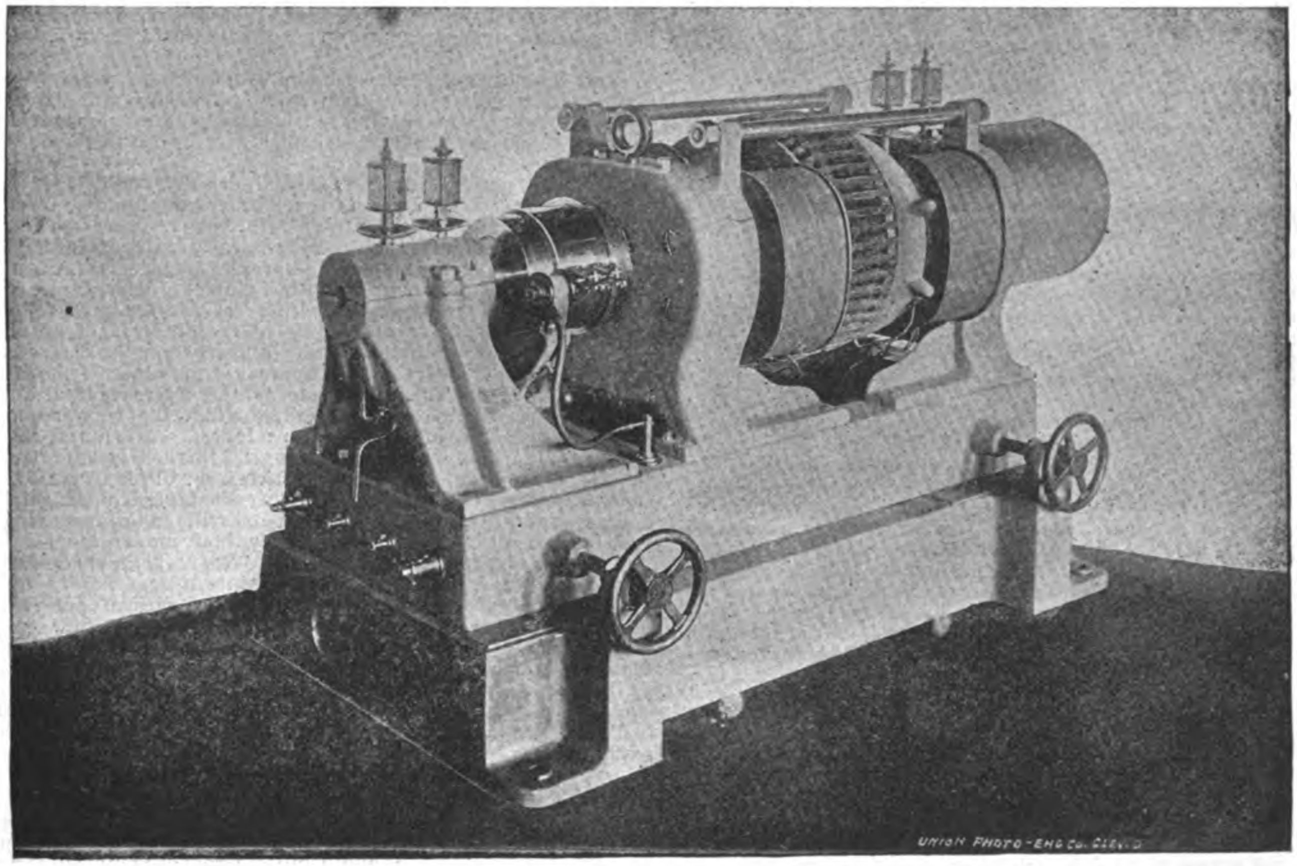
THE accompanying illustration shows the dynamo and motor recently designed by Mr. S. H. Short, the chief electrician of the Brush Electric Co.

The generator is capable of furnishing 100 h. p. at its pulley. The armature is of the closed coil type and its core is made up of thin sheet iron wound on a foundation ring and firmly riveted; the edges of this ring are then milled out slightly to allow for the bobbins of wire. The wires leading from the armature to the commutator are carried along the shaft, and are very carefully and thoroughly covered to protect them from dirt or damage of any kind. The bearing on the commutator side of the dynamo is placed outside of the commutator so as to allow a clear way for the connections between armature and commutator.

These generators are very compactly built, and the ventilation obtained is practically perfect. Any part of the machine can be inspected without disarranging other parts, and, in case of accident, the armature or magnets can be removed quickly, and repaired with little trouble. Any one of the armature bobbins can easily be rewound without disturbing the remaining bobbins.

The construction of the motor is very similar to that of the generator. One point, however, deserves special attention, and that is, the fact that the motor requires no outside governor of any kind, being entirely automatic in its regulation.

These generators and motors will be wound for an E. M. F. of 1,000 volts, thus allowing power to be carried over a considerable distance by means of a comparatively small wire. The new type of commutator, with which both motor and generator are fitted, runs with practically no spark, so that there is no trouble at that usually troublesome point.



BRUSH CO'S NEW DYNAMO AND MOTOR.

DIFFERENT FORMS OF CARBONS USED IN ARC LIGHTING.[1]

BY E. P. WARNER.

IN the period just preceding the introduction of the arc electric lighting commercially, experimenters and inventors had brought forward numerous plans, ideas, and theories regarding the size, form and manner of using carbons, and in view of the fact that no reasonably cheap method of generating the electric current then existed, a surprising amount of attention was given to the subject, and the developments of the art shown by many publications form no small part of our history of arc lighting.

It is not my purpose to dwell at length upon the history of carbons generally, but rather to touch lightly on some of the more notable forms known at the time of which I am speaking, and then to pass on to a consideration of the utility and practical results obtained with the different forms of carbons in use at the present time, paying special attention to the matter of form and size as affecting the results.

The form of a cylinder or pencil, it is noteworthy, was that used by Sir Humphrey Davy, in his earliest experiments, and he even devised special holders or clamps to retain the carbon pencils in alignment and facilitate their adjustment with a view of maintaining a constant and steady light. Archereau subsequently adopted the pencil form of carbon and used it in his lamp, now so justly considered as the first practical arc lamp; it does not appear, however, that he turned his attention particularly to the matter of form. Wright and others stand on record as experimenters with carbon discs brought edge to edge and made to rotate as they were consumed, and the combination of a disc placed on edge above a vertical pencil of carbon was also tried at this early date.

Wallace and Farmer made use of broad, flat plates of carbon, placed in a vertical plane, one above the other, the arc forming between the edges as they were drawn apart and shifting back and forth from one end of the plates to the other. Another inventor, at about this same date, placed flat plates of carbon side by side and an intervening insulation of some refractory material, the arc forming at the upper edges of the plates, and gradually consuming them. Jablochkoff in 1876 introduced his well-known electric candle, a form of arc lamp in which cylindrical carbons are employed, placed in a vertical position, and held separated by a thin filling of refractory insulating material.

Now, when we look back at the work of these early inventors, and consider what special object they had in mind in making their experiments, it is at once apparent that it was continuity of action, and it stands on record that they met with fair success so far as that feature is concerned, some of the lamps being capable of twenty hours' burning without attention.

In 1874, Mathias Day produced an arc lamp in which two cylindrical pencils were placed in the upper holders, and two in the lower holders, the upper ones occupying a plane with the lower and directly over them; here the avowed object of the invention was to secure long-continued operation of the light without requiring attention, and it is certain that he accomplished it in a very creditable and ingenious manner.

Coming now to the time of the commercial birth of arc electric lighting, we find Jablochkoff in the lead, closely followed by Brush and Weston, each making use of the cylindrical form of carbon pencil, and turning their attention most assiduously to the feature of continuity of operation, the first move being an increase in length of the pencils. Carré, a French manufacturer, at this time, became prominent as a maker of carbons, and succeeded in producing pencils about $\frac{7}{8}$ inch diameter and 32 inches in length, and it was thought, by the use of lamps of suitable length, these long carbon pencils could be advantageously used when long-continued burning was a necessity, but owing to the difficulties encountered in the manufacture, and also trouble in maintaining proper alignment for the carbons, a length of 22 inches was soon settled upon as most practicable and convenient.

As the business increased and the demands became better understood, the inventors again essayed to solve the problem of continuity of action, but, in many cases, such attempts were but returns to old forms and methods, and did not result in any practical advance.

Various forms of double carbon lamps were introduced, and, for a time, these were thought to be the only practical and commercially successful way out of the difficulty, but more recent developments have shown a far simpler and better way, and one, furthermore, that cannot fail to impress the practical electrical engineer. I refer to the simple expedient of using a carbon pencil of $\frac{5}{8}$ inch diameter, 14 inches in length, in an ordinary single carbon lamp. It is true that this is not new, and that carbon pencils of such size, or even greater, were tried long ago; nevertheless, the introduction of carbons of this size and form has a very great bearing on the commercial side of the situation; but before going into that matter I wish to say a few words regarding the lighting efficiency of $\frac{5}{8}$ inch carbons.

Having noticed that the question had been raised as to whether these carbons would give as much light for a given expenditure of electrical energy as would those of one inch diameter, I tried the following experiments:

Two single lamps were connected in series in an arc circuit, one being supplied with $\frac{5}{8}$ inch carbons 14 inches in length, the other with $\frac{1}{2}$ inch carbons 12 inches in length; around each lamp was branched a voltmeter indicating the voltage. The lamps were then adjusted until they had the same voltage, and as the current was of necessity the same in each, it was a safe conclusion that equal amounts of energy were being supplied. Photometric comparison of the two lights was then made at the horizontal and at many different angles above and below, with the result that no perceptible difference could be found in the power of the lights; during the tests the current was maintained as constant as practicable and care was taken to base the comparison on an average deduced from a large number of readings.

Now, while this matter of lighting efficiency is one that concerns the people operating electric plants, it does not interest them to the extent that other features upon which I have yet to touch may, as I happen to know that the management of lighting stations look long and lovingly on any plan that seems to give good promise of reducing running expenses. To begin with, there is the difference in first cost between a single and double carbon lamp, and the difference in the expense for repairs and attendance, these items varying of course with the different lighting systems. Still another important saving is in the cost of carbons, the cost for a given number of hours' run being fully thirty per cent. greater with $\frac{1}{2}$ inch than with $\frac{5}{8}$ inch carbons. There is the further important saving in the breakage of globes which often is caused by the sudden shifting of the arc in the double carbon lamp.

Twin carbons consisting of two cylindrical pencils placed parallel and in close juxtaposition to each other other, and connected by a web throughout their entire length, have of late been introduced, and when in use the arc alternates between the different pencils comprising the upper and lower twin carbons. A test of these carbons made principally with a view of determining the life and lighting quality gave unsatisfactory results in the following particulars: It was observed that the duration of burning for a given weight of material was not nearly equal to that which could be obtained with the same amount of material in a single cylindrical pencil. This I attribute to the more rapid disintegration of the twin carbon resulting from the very frequent heating and cooling of each member; indeed this is found to be true of two carbons which were arranged as in the Day lamp, or so that the arc alternates frequently between the different sets, and there is quite a noticeable difference in consumption of carbon for a given duration of lighting as compared with an ordinary single carbon of the same diameter burning without interruption.

Another undesirable feature of twin carbons is the shadow cast by the non-burning members, which, while it may not be disagreeably noticeable when the lamp is provided with an open globe, most certainly operates to reduce the total output of light.

It may be argued that the main item of expense in the manufacture of carbons does not lie in the material, and the fact that $\frac{5}{8}$ inch carbons cost so little more than $\frac{1}{2}$ inch, would bear out such a position, and I have merely mentioned the fact of the rapid disintegration and burning away of the twin carbons by way of explanation.

1. A paper read by title before the N. E. L. A. at Montreal, P. Q., Sept. 12, 1891.

ELECTROCULTURE.

EXPERIMENTS have been carried out in France, in Lot-et-Garonne, by M. Barat, upon the application of electricity to the culture of potatoes, tomatoes and hemp. A row of hemp, subjected to the influence of the electric current, produced a row of stalks 18 in. higher than those not electrified in the same time. A kilogramme (2.2 lbs.) of potatoes planted in the path of the current produced 21 kilogrammes of very large and healthy tubers, while the unelectrified patches only gave $12\frac{1}{2}$ kilogrammes of medium size. The electrified tomatoes also became ripe some eight days before the others. A curious fact has been remarked by M. Barat in his experiments. If a quantity of manure is near the positive pole, the constituent parts of this manure are transported towards the negative pole, and their effects make themselves felt around a distance of some yards. This would seem to be a fresh proof of the opinion long advanced upon the part played by electricity in the growth of plants, an opinion also adopted by M. Specnew, who has given some attention to these phenomena; this is, that the action of the electric current upon plants seems to consist in the more active dissolution of the organic principles existing in the soil which are thus brought within the reach of the roots.

WHAT IT WAS THAT SAVED HIM.

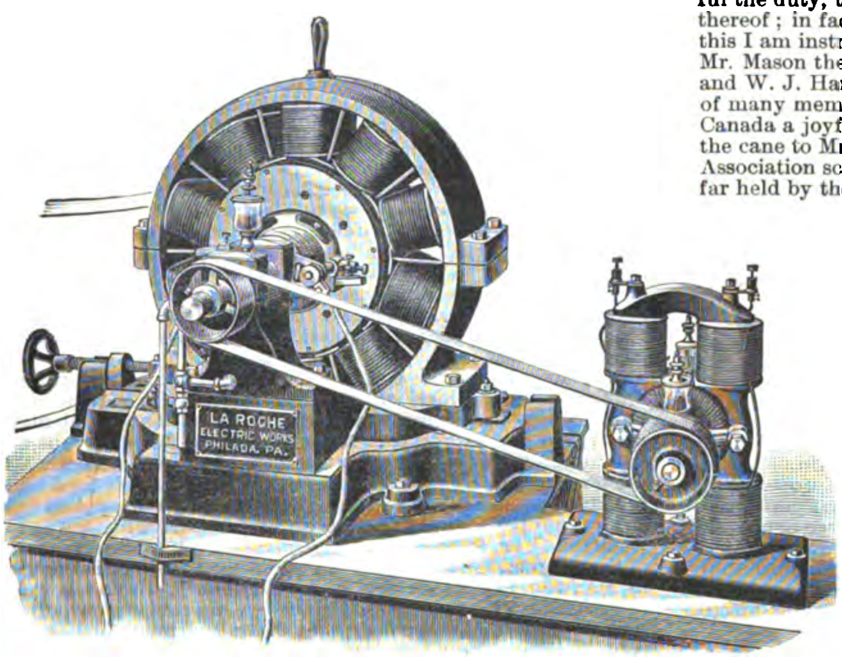
EXPLAINING why a lineman recently escaped with his life after making contact with a live arc light wire, the *Saginaw News* says: "Fortunately the wire was a small one and he had taken a firm hold of it; otherwise, as the dynamo at the works was running 2,000 voltage power, he would have been instantly killed. A slight contact, it appears, is much more dangerous."

THE LA ROCHE ALTERNATING SYSTEM.

ALTHOUGH alternating dynamos have been made for several years by the La Roche Electric Works, of Philadelphia, the march of progress in the electrical field has led to the design of a machine embodying several improvements peculiar to itself.

This dynamo is shown in the accompanying illustration. It is set on an insulated base, the belt tightener being also insulated to avoid any possibility of accident, and is so constructed that in case it should be necessary to remove the armature, the top or one-half of the fields can easily be taken off by one man. The iron in the fields is made expressly for this purpose, and the coils being locked by a new style of bolt, can be taken off or put on without any adjustment whatever.

The armature has no iron supports, and the brushes and brush holders are automatic and self-adjustable, and are claimed to have absolutely no wear at the collector rings. The insulation is of mica throughout.



THE LA ROCHE ALTERNATING DYNAMO.

None of these dynamos have ever been known to burn out by excessive load or lightning, and, although some have been put to the severest tests, they have given perfect and universal satisfaction. They are entirely automatic, and run at very slow speed.

CONVENTION AFTERMATH.

AFTER the adjournment of the National Electric Light Association, and after the famous trip on the Richelieu River, about 50 of the delegates and members visited the Citadel City of Quebec. They were guided by Mr. A. J. Corriveau and Mr. Mohr, manager of the Quebec Electric Light Company. On Sunday they were taken in carriages to the Citadel, over the Heights of Abraham, and through the city generally, visiting the Basilica and other points of interest. On Monday the party were taken in carriages to the Montmorency Falls. On the heights above the falls is the ancient building which a century ago was the home of the Duke of Kent, the father of Queen Victoria. Into the grand old home they were welcomed by Mr. and Mrs. Hall, who now own this beautiful place. A royal lunch was spread, and a delightful hour was spent with this hospitable lady and gentleman.

From the veranda of their house one looks over the mighty St. Lawrence River, which here is two miles wide. The continuous roar of the falling waters of Montmorency as it makes its grand leap of 250 feet over a perpendicular precipice made fair music in a perfect diapason. The waters of this river furnish an inexhaustible power which is utilized for the running of large mills, and also for the Quebec Electric Light Station. The visitors missed the night view from this point. They were told that at this season the Aurora Borealis shoots its continuous rockets into the dark northern air, but that, splendid as are these natural scenes, they are outrivaled by the illumination of the Citadel and the city of Quebec, lighted by electric lights, six miles distant, and which form a half-circle of several hundred suns, each equal to the splendid Venus when at her brightest, all reflected in the still waters of the river below.

This wonderful water-power is controlled by Messrs. Hall and Price. The water is conducted from above the falls in large pipes to the mills and to the electric light station. In this station are 16 dynamos, supplying the current for 300 arc lights and two 750-light machines for incandescent lighting. Over 1,200 miles of conductors are in use. More dynamos are being built for this station, their present supply being all inadequate to meet the demand.

On Monday the party returned to Montreal, and on Tuesday Mr. Corriveau was the most surprised man in that city. In behalf of the members remaining in Montreal, an elegant gold-headed cane was presented to Mr. Corriveau. Mr. A. F. Mason, in making the presentation, said to Mr. Corriveau: "Sir, during the last week certain gentlemen have had their eyes upon you and have observed conduct of yours which they cannot overlook, and however painful the duty, they feel called upon formally to take this notice thereof; in fact, they have determined to cane you. Before doing this I am instructed to read you this formal communication." Mr. Mason then read a letter signed by himself, W. J. Morrison, and W. J. Hammer, as a committee, conveying the appreciation of many members of his successful efforts to make their visit to Canada a joyful and pleasant one. Mr. Morrison then presented the cane to Mr. Corriveau. After this episode the members of the Association scattered, and so ended the grandest meeting thus far held by the National Electric Light Association.

THE STANDARD ELECTRICAL WORKS.

THE above company, in their capacity of Cincinnati agents for the Western Electric Co., of Chicago, have been awarded the contract for the wiring of the new City Hall, in the fomer city. This company was organized and incorporated about ten years ago, since which time they have steadily extended their operation until now their working territory covers a wide scope of country.

They handle extensively the Okonite wire, and have furnished over $100,000 of this material to the street railroads of Cincinnati and vicinity. This company furnish buildings with complete electrical plants in any section of the South and West. They have just placed the electric plant in the Neave building, one of the largest office buildings in Cincinnati, and the City Hospital, Pike's Opera House, Crane, Breed & Co., Addyston Pipe Works and others.

College Notes.

UNIVERSITY OF WISCONSIN.

As our readers are aware, Mr. Dugald C. Jackson has recently been appointed professor in charge of the electrical course of the School of Mechanics and Engineering of the University of Wisconsin, Madison, Wis. The circular issued as to the reorganization in this branch of studies is very interesting, as it sounds the first note in a call for a departure from the old and established methods in vogue in engineering colleges. Coming from the West, it shows how rapidly the demand for thorough technical training has taken root on the prairies. The division of engineering into three branches, sharply defined, is abandoned, and it is split up into a number of co-ordinate courses, each of which has at its head a specialist, who is entirely independent within wide limits. Far better results are expected.

The university as a whole has a reputation unexcelled west of the Alleghany Mountains, and equaled by only one other institution. With about 1,000 students, and a liberal income, its influence is strengthening. The president is Mr. T. C. Chamberlain, one of the geological authorities of the country, and a man in sympathy with liberal technical education. Under these conditions, Prof. Jackson hopes to make the electrical engineering course the best in the country. His facilities are already excellent and will at once be greatly improved.

ALABAMA POLYTECHNIC INSTITUTE, AUBURN, ALA.

The electric laboratory of the Alabama Polytechnic Institute is being rapidly equipped with dynamos, motors, accumulators, instruments, etc. The authorities intend to make this the leading electrical school of the South. Prof. A. F. McKissick is in charge of the electrical department.

MR. THOMAS F. CLOHESEY, the electrical engineer, of Kansas City, has been publishing an excellent article on the "Transmission of Electricity," in the *Kansas City Architect and Builder.*

Society and Club Notes.

NEW YORK ELECTRIC CLUB

THE club will resume its entertainments on Thursday, September 24, 1891, at 8 p. m., when Mr. Allen R. Foote, the special agent for the collection of the statistics of the electrical industry for the Eleventh Census, will read a paper on "The Making of a Model New York City."

This paper will deal, in an original manner, with the industrial and social needs of the city, the problems of rapid transit and workingmen's homes, and the relation borne by electricity to the evolution of a perfected New York.

AMERICAN STREET RAILWAY ASSOCIATION.

THE rate of a fare and a third has been allowed to delegates and all others, including members of their families, in attendance at the tenth annual meeting of the Association, which will be held in Pittsburgh, Oct. 21, 22 and 23, by the following traffic associations, namely, Boston Lines Passenger, Central Traffic, New York and New England Passenger, Southern Passenger and Trunk Line; also on the Chicago and Alton Railroad from all points in the State of Illinois. Michigan is excepted from the Central Traffic Association. The above covers nearly all the United States, with the exception of the territory controlled by the Western Passenger Association.

Letters to the Editor.

IN your issue of August 19 (p. 210), under the title of "Electric Traction at Bremen," we find it stated that the Bremen Strassenbahn-Gesellschaft was the first company in Europe to purchase outright an electric tramway. It seems that you are not aware of the existence and successful operation since September, 1890, of the Electric Tramway Florence-Fiesole, owned by the "Societa Italiana per il Tramvia del Chianti e dei Colli Fiorentini," which has been completely equipped with American electrical apparatus by Mr. E. P. Wetmore, expert of the Sprague Electric Railway and Motor Company, of your city.

This is the most remarkable electric line operating on our continent, and it possesses many special features not met with in any other road which we are aware of.

SOCIETA ITALIANA,
PER IL TRAMVIA DEL CHIANTI E DEI COLLI FIORENTINI.
FENZI, *President*.

FLORENCE, ITALY, September 5, 1891.

Literature.

The Electromagnet and Electromagnetic Mechanism. By Silvanus P. Thompson, D. Sc., B. A., F. R. S. London and New York, 1891. *E. & F. N. Spon.* Cloth, 450 pages, 5 x 8 inches.

ALTHOUGH magnetism in general—and the electromagnet in particular—has absorbed the attention of, and been the subject of the closest study by, some of our most able physicists, the fact, nevertheless, remains that until recently the student who desired to avail himself of the knowledge and results which have been obtained found himself confronted by a vast amount of literature which but few were so situated as to command and employ with profit. The truth of this was proved by the avidity with which Prof. Silvanus P. Thompson's lectures before the London Society of Arts, on the Electromagnet, were read by the numerous class interested in this subject at present, and these lectures only served to whet an appetite which, we are glad to say, Prof. Thompson has now succeeded in satisfying to a measurable degree in the volume before us.

The present work is an amplification of the Cantor lectures, but such an amplification as entitles it to rank practically as an independent work. Before taking up the subject in detail, Prof. Thompson gives an excellent introduction, in which he traces the history of the electromagnet, dating from the discovery of Oersted, which finally found its application in the electromagnet of Sturgeon. These are followed by the researches of Henry, Wheatstone and Joule, and descriptions and dimensions of notable magnets, among which we note the gigantic electromagnet constructed by Major King, U. S. A., by winding the muzzle ends of a pair of 25-ton guns. Prof. Thompson then takes up the discussion of the electromagnet in general, and the properties of the magnetic lines emanating from it, and discusses the elementary propositions in electromagnetics, which give the reader an excellent idea of the direct application of electromagnetic units. Then follow the descriptions of typical forms of electromagnets, beginning with the straight-bar magnet, and passing through the various forms of two-pole magnets, the iron-clad magnet, etc. Not the least interesting addition to this chapter is the description of the materials required for the proper construction of the cores, the coils and the insulation.

Looked at from the standpoint of of the constructor of electromagnetic apparatus, Chapter III., on the properties of iron, will command a good share of attention. It is evident that a knowledge of the exact magnetic properties of the metal entering into the construction of any electromagnetic apparatus is necessary in order to predicate at all accurate results, and, recognizing this, the author has justly devoted considerable space to its consideration. He begins by discussing the diagram of the curve of magnetism for the various magnetic materials, such as iron and steel, soft and annealed, etc., and thus leads up to the various methods of measuring permeability, among which we find that of Hopkinson carried out in detail. The various results obtained by Ewing, Rowland and Bosanquet, all of which are directly applicable, are also given with considerable fullness. Prof. Thompson has rightly laid special stress on the effect of the air gap in the magnetic circuit, the influence of which is pointed out in a very clear manner, and cannot be too strongly impressed upon the mind of the student. Under this head also we note a discussion of the effect of joints in the magnetic circuit, and straight cores of various lengths; also those of vibration and of heat, which latter, we believe, is destined to play a more important part in the construction of electromagnetic apparatus, especially converters, than has heretofore been contemplated. Magnetic hysteresis, with some other minor properties of magnetic bodies, closes a chapter of surpassing interest.

The author then takes up the principle of the magnetic circuit, the treatment of which will be quite refreshing to those who have been brought up on the older works, of which that of Dub may be said to be the prototype. After explaining the law of the magnetic circuit, and stating it in the form of an equation, viz., that the magnetic flux equals the magnetomotive force divided by the reluctance, the author shows how this law can be applied to the various properties of the magnet, and begins with the law of "traction" or what was formerly called the "portative force" of the magnet. After noting the law of magnetic attraction given by Maxwell, and its verification by Bosanquet, we find a variety of designs of electromagnets for tractive or carrying purposes, together with the methods of calculation and the influence of the polar surfaces, and a large amount of information which can be applied in many ways in the workshop.

The succeeding chapter explains the law of the magnetic circuit applied to cases of attraction of an armature at a distance, and here, of course, the calculation of magnetic leakage enters into the problem, and is treated in the same lucid manner as applied in the former chapter, the practical examples given enabling the experimenter to repeat directly, or apply the principles enunciated. This is followed by a discussion of the various shapes of armatures and their influence on the action of the electromagnet. The rules for winding copper wire coils on magnets are here fittingly introduced, and some valuable tables contained in this chapter will be found of great use. The author then takes up the special designs of magnets to produce rapid action such as that required in relays and chronographs. Chapter VIII. is devoted to that familiar form, the coil and plunger magnet, and contains a complete description of the work done on this type, and the laws of its action.

Having thus described the general appearance and types, the author describes various mechanisms in which the magnet in one form or another is the actuating device, including the presentation of its application to arc lamps and regulators of all kinds, polarized electromagnetic devices, including the relay and the telephone, etc. Electromagnets operated by alternating currents also receive their proper share of attention, a subject which we believe has here for the first time been systematically presented, and the importance of which is evident in view of the increasing application of alternate current apparatus involving magnets in their construction. In a short chapter there are also described the older forms of electromagnetic motors, such as those of Ritchie, Jacobi, Froment, etc., in which the action was due to the successive attraction of electromagnets.

The work ends with a series of short chapters on electromagnetic machine tools, such as hammers, riveters, etc., the modes of preventing sparking in the operation of electromagnets, the electromagnet in surgery, and a very extended discussion of permanent magnets and their properties. Three appendices also give respectively a biography of William Sturgeon, a short exposé of electric and magnetic units, and the calculation of excitation, leakage, etc.

We have here but briefly hinted at the contents of a work which is easily the most complete and valuable of its kind available at the present time. Aside from the fascination of the subject itself, the author's easy diction lends an added charm to the work, so that the reader is not only thoroughly instructed, but positively entertained. There are few technical works of which this can be said, and we think no higher praise than this can be bestowed. It adds another to the many lasting obligations which every electrical reader owes to Prof. Thompson, whose books have had such a powerful formative influence on the younger generation of electrical engineers. The work is handsomely gotten up in clear type, and we are glad to note that the illustrations are clear and well executed throughout.

Patent Notes.

DECISION OF THE COMMISSIONER OF PATENTS IN THE INTERFERENCE CASE OF RUDOLPH M. HUNTER vs. FLEEMING JENKIN.

THIS was a rehearing of an interference which was originally declared by the Patent Office on November 22, 1887. The invention in issue is the well-known system of electric telpherage devised some years since by Professor Fleeming Jenkin. The issue was originally decided by the Examiner of Interferences in favor of Hunter, but the Board of Examiners-in-Chief, on appeal, decided in favor of Jenkin, as noted in THE ELECTRICAL ENGINEER of Oct. 15, 1890. Hunter then took an appeal to the Commissioner, which was decided by Assistant Commissioner Fisher in his favor, reversing the decision of the board. Jenkin's attorneys then petitioned for a rehearing, alleging that the last-named decision was contrary both to the law and the evidence, and a rehearing was granted by Commissioner Mitchell, which, however, did not come up until after he had resigned and turned over his office to his successor.

One of Jenkin's patents for the improvement in controversy was dated September 16, 1884, having been applied for February 1, 1883; he has also a British patent for the same thing, dated April 17, 1882. It appeared that the contestant Hunter conceived of the invention in 1879, and applied for a patent May 22, 1886, with no intervening reduction to practice. It appeared that he did reduce it to practice subsequently to his application. Between his conception of the invention and his application for a patent he was interested in the procurement of 21 other patents. The Commissioner says:—

"The general rule is that he who is the first to conceive of an invention is entitled to a patent for it if he reduces the same to practice with reasonable diligence; but if he do not reduce to practice with reasonable diligence, he who is subsequent to conceive but first to reduce to practice will prevail."

"'In a race of diligence between two independent inventors he who first reduces his invention to a fixed, positive and practical form would seem to be entitled to a priority of right to a patent therefor. The clause now under consideration seems to qualify that right by providing that in such cases he who invents first shall have the prior right, if he is using reasonable diligence in adapting and perfecting the same, although the second inventor has in fact perfected the same and reduced the same to practice in a positive form.'" (*Reed* v. *Cutter*, 1 Story, 590.)

Other cases cited are: *Ransom et al* v. *N. Y.*, 1 Fisher, 252; *Savary et al.* v. *Lauth*, 1 Mac A. P. C., 691; *Johnson* v. *Root*, 1 Fisher, 351.

In reference to the question of constructive reduction to practice, the Commissioner says:

"An application for a patent which eventuates in the grant of a patent is constructive and presumptive reduction to practice. This is so, in the first place from necessity, for there is no other logical way of treating an application for patent in this regard. It is so in the second place, because of the fundamental reason for granting patents, that is, 'to promote the progress of science and the useful arts,' and he who makes the disclosure to the public in a patent, benefits the public in this regard equally with him who makes the disclosure by actual reduction to practice. In a contest for priority of invention, the presumption referred to is conclusive against all of the parties to the proceeding, because each one is, by the fact of his making a claim to the improvement in dispute, estopped from denying its operativeness and completeness. The reasonable diligence which is required in a contest over priority of invention applies alike to actual reduction to practice and to the constructive reduction to practice involved in an application."

"'Where the invention is not of a mere philosophical speculation, abstraction or theory, but of something corporeal, something to be manufactured, the applicant need not show that he has reduced his invention to practice otherwise than by filing his specification and furnishing drawings and a model, as required by the statute, where the nature of the case admits of drawings or of a representation by a model.'" (*Heath* v. *Hildreath*, 1 MacA. P. C., 12.)

Although a party may be prior in the date of making his invention, he—

"must proceed to perfect and patent it with due diligence, otherwise a succeeding inventor who is more diligent in perfecting his, though not in getting out a patent, may prevail against or defeat him." (*Allen* v. *Blunt et al.*, 2 W. & M., 121.)

Reducing to practice differs from bringing into use. There is no law requiring the applicant to reduce his invention to actual use before he can obtain a patent. (*Perry* v. *Cornell*, 1 MacA. P. C., 68.)

Other cases cited are *New England Screw Co.* v. *Sloan*, 1 MacA. P. C., 210; *Stephens et al.* v. *Salisbury*, ibid. 379; *Ellithorp* v. *Robertson*, ibid. 585; *Farley* v. *National Steam Gauge Co.*, ibid. 618; *Seymour* v. *Osborn*, 11 Wall., 516; *Hubel* v. *Dick*, 28 F. R., 132.

In the present case Jenkin had a patent, while the contestant Hunter was a subsequent applicant. In view of this state of facts, the Commissioner holds:

"When one of the contestants has a patent for the invention in dispute and the other is an applicant for a patent, the latter, in order to prevail, must present a case, both as to conception and as to reasonable diligence, which does not admit of a reasonable doubt. This is as it should be. The issue of a patent is an event that is deliberate, certain, and official, in a high sense. It ought not to be lightly set aside. The courts have agreed that in all attacks upon it of this same general nature (*i. e.*, on the ground of public use, prior use, abandonment, or prior invention), a case, in order to succeed, must be made out beyond a reasonable doubt."

"'It is not enough, to defeat a patent already issued, that another conceived the possibility of effecting what the patentee accomplished. To constitute a prior invention, a party alleged to have produced it must have proceeded so far as to have reduced his idea to practice and embodied it in some distinct form. It must have been carried into practical operation.'" (*Parkhurst* v. *Kinsman et al.*, 1 Blatch., 488)

Other cases cited: *Ellithorp* v. *Robertson et al.*, 4 Blatch., 307; *Cox* v. *Griggs et al.*, 1 Bissell, 362; *Brodie et al.* v. *Ophir Co.*, 5 Sawyer, 608; *Draper* v. *Potomska Mills*, 3 B. & A., 214; *U. S. Stamping Co.* v. *Jewett et al.*, 18 Blatch., 469; *Electric R. R. Signal Co.* v. *Hall R. R. S. Co*, 6 F. R., 603; *Union Met. Cartridge Co.* v. *U. S. Cart. Co.*, 7 F. R. 344: *Odell* v. *Stout*, 29 O. G., 862.

Hunter, in his evidence, sought to excuse his delay on account of lack of means and the necessity of devoting a large part of his time to other inventions. Respecting this, the Commissioner holds that time spent upon other inventions does not excuse delay otherwise unreasonable. This proposition is established in *Signal Co.* v. *Molecular Telephone Co.*, 23 Blatch. 253; *Telephone Cases*, 126 U. S., 1.

As long ago as 1859, Judge Merrick stated this principle as follows:

"If a man be utterly destitute of money and without friends, and incapable thereby of prosecuting an enterprise, much indulgence may be shown to him; but where he has the means of carrying on sundry enterprises of a kindred sort, equally demanding money and friends, and does carry them on, his elections to pursue those other enterprises will not be regarded in the law as an excuse for delay in the one where valuable rights of others equally meritorious with himself, and in the outset of their successful struggles, equally poor, are to be prejudiced. An election thus made for his supposed advantage or gratification at the time, according to the plainest principles of equity, must not be invoked for the subsequent detriment of another innocent party." (*Wickersham* v. *Singer*, 1 MacA. P. C., 645.)

Applying these principles to the case in hand, the Commissioner reverses the decision of the former Assistant Commissioner and awards priority to Jenkin.

Legal Notes.

SUING UNDER THE EDISON LAMP PATENT.

THE Edison Electric Light Company has begun suit against the Mount Morris Electric Light Company for infringement of Edison patents in incandescent lamps, in the United States Circuit Court. The Edison Company asks for an accounting of all profits made by the Mount Morris Company and for an injunction restraining them from using the alleged infringed improvements.

TELEPHONE vs. ELECTRIC RAILWAY AT TROY, N. Y.

JUSTICE EDWARDS, in the general term at Saratoga last week, handed down a decision reversing the decision of Referee Isaac Lawson in the case of the Hudson River Telephone Company against the Watervliet Turnpike and Railroad Company. Referee Lawson denied the application of the telephone company for a perpetual injunction restraining the railroad company from operating its line by electricity and dismissed it with costs. This decision returns the case to its former standing, the injunction being revived and the railroad company compelled to furnish the security demanded by the telephone company, if an appeal is taken to the court of appeal. The telephone company will now bring a suit for damages.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED SEPT. 8, 1891.

Alarms and Signals :—

Telegraphic Transmitting Apparatus, M. Martin, 459,018. Filed July 14, 1890.
Designed to be operated automatically when the message is to be sent, as, for example, upon the breaking out of a fire.

Conductors, Conduits and Insulators :—

Support for Electric Conductors, G. H. Winslow, 459,168. Filed May 19, 1891.
Relates to improved devices for supporting overhead trolley wires and has for its object a construction which can be quickly and easily applied to the conductor and will offer but slight obstruction to the movement of the trolley.

Electric Conductor, E. D. McCracken, 459,378. Filed Mar. 5, 1891.
Relates to that class of insulated conductors in which a paper ribbon constitutes the insulating material.

Flexible Electric Conductor, H. W. Libbey, 459,385. Filed July 26, 1889.
Consists in placing upon the wire oblong beads of glass with rounded ends and inserting them in a flexible india-rubber tube.

Dynamos and Motors :—

Controlling Mechanism, C. R. Pratt, 459,090. Filed Oct. 30, 1890.
Claim 1 follows :
Combination of a motor having a suitable source of power for driving it, a controlling device for the motor made in two sections, one for admitting said power to the motor in one direction, and one for admitting power to the motor in the opposite direction, and a lock operated by the movement of either section to hold the other in its normal position.

Electrically Operated Brush, F. A. Lehmann, 459,222. Filed Oct. 25, 1890.
Consists in the combination of a handle formed by the field-magnet and a longitudinal shaft having a revolving armature at one end and a revolving brush at the other.

Armature for Dynamo Electric Machines or Motors, R. Lundell, 459,866. Filed Nov. 24, 1890.
Consists of a novel winding of the armature coil in an improved mode of insulating and protecting the coils and inserting other features of construction.

Commutator-Brush and Holder, R. Lundell, 459,367. Filed Apr. 4. 1891.
Relates to devices for conducting currents from a supply-circuit to the armature of an electric motor or to take current from the armature of the dynamo to supply an external circuit.

Commutator-Cylinder and Method of Making the Same, R. Lundell, 459,368. Filed Apr. 4, 1891.
Claim 1 follows :
A commutator cylinder composed of alternate conducting and insulating sections, a filling of insulating material between the cylinder and a sleeve or shaft on which it is mounted and a metal ring imbedded in said insulating material.

Lamps and Appurtenances :—

Electric Light Fixture, E. T. Greenfield, 459,098. Filed May 11, 1891.
Has for its objects the production of a socket for use with different types of incandescent lamps and of a simple and effective switch mechanism.

Incandescent Electric Lamp, E. P. Roberts, 459,100. Filed July 15, 1891.
Relates to an improved method of connecting the socket to the bulb of an incandescent lamp.

Hanger for Incandescent Lamps, P. J. Chassagne, 459,266. Filed Jan. 16, 1891.
Provides a spring-actuated roller around which is wound a flexible cord conducting the current to the lamp.

Medical and Surgical :—

Electrode for Chairs, G. W. Overall, 459,127. Filed July 8, 1891.
Relates to the application of electrodes for use in vapor baths, etc.

Electro-Therapeutic Truss, H. W. Matthews, 459,143. Filed June 26, 1891.

Electro-Therapeutic Belt, H. W. Matthews, 459,141. Filed June 26, 1891.

Miscellaneous :—

Electrically-Heated Wristband-Ironer, W. Mitchell, 459,070. Filed Nov. 29, 1890.
Employs a rotary cylinder in combination with a stationary device for heating and pressing the article to be laundered.

Mechanism for Operating Dampers or Similar Valves, J. V. Stout, 459,091. Filed Mar. 9, 1891.
Relates to means of automatically opening and closing a damper by means of an electric current.

Electric Switch, L. D. Castor, 459,219. Filed May 20, 1891.
An electric snap switch actuated by a removable key.

Electric Elevator, H. H. Blades, 459,229. Filed Sept. 19, 1890.
Has for its object the simplification of electric elevator mechanism by providing the elevator with a storage battery as a counterpoise weight.

Process of Purifying Brine, C. G. Collins, 459,236. Filed Dec. 2, 1890.
Renders impurities contained in brine insoluble by means of the passage of an electric current.

Fuse and Detonator, P. Ward and E. M. Gregory, 459,321. Filed May 13, 1890.
A cheap fuse and detonator uniformly sensitive to a small current of electricity and protected against the influences of moisture and climate.

Electric Contact Apparatus, C. Weuste, 459,323. Filed June 12, 1890.
Has for its main object the indication of the level of water in reservoirs, &c., upon a dial at a great distance through the medium of an electric current.

Railways and Appliances :—

Mounting for Motors of Electric Cars, S. H. Short, 459,024. Filed Dec. 24, 1890.
Relates to the mounting for the motors of electric cars which have their armatures axially placed with reference to driving axle and directly connected with the same.

Railway-Car Step, H. C. Farquharson, 459,170. Filed Jan. 8, 1891.
Claim 6 follows :
The combination of a stationary step, of a movable step, side bars for supports for the same and a circuit closer actuated by the movement of the step, an electromagnet and an alarm operated thereby for giving a signal when the movable step is in its depressed position.

Telephones and Apparatus:—

Telephone Receiver, J. H. Howard, 459,205. Filed March 3, 1891.
An improved telephone receiver embodying in its own construction the switch which cuts out from the circuit the coil of said receiver when the receiver is not in use.

Hook or Crotch for Telephone-Receivers, J. H. Howard, 459,218. Filed March 3, 1891.
A support for the receiver of the telephone when not in use.

Telephone, J. H. Howard, 459,214. Filed March 3, 1891.
Has for its object a construction which shall allow the current of the primary circuit to pass around the Siemens armature when the armature is not in use, thus avoiding the resistance of the armature coil.

THE AURORA INCLINOMETER.

Before the Mathematical and Astronomical Section of the A. A. A. S., at Washington, Prof. Bigelow exhibited and explained a new instrument called the aurora-inclinometer. Prof. Bigelow has been working for some years on the problem of the physical interactions between the earth and the sun aside from those due to gravitation. Several important discoveries have already been made. It has been found that the same law which underlies the working of electricity and magnetism is operating on the sun and gives the beautiful curves of the corona which are seen at the times of total eclipses. This corona is like the aurora and is confined to a narrow belt in each hemisphere of the sun.

Prof. Bigelow believes he has discovered the causes of terrestrial magnetism and the variation of the magnetic needle all over the earth in periodic motions. He assumes that the sunlight acts as a magnetic field, and that the magnetized earth rotates in it, just like the armature of a dynamo. By a sort of magnetic refraction the rays of force enter the dark side of the earth in peculiar curves, pass through it in straight lines, and emerge in similar curves on the sunny side of the earth, turning all the needles in a corresponding way. Now, the aurora marks the pathways by which these forces enter and leave the earth, or the modifications that are produced by them, or the ordinary magnetic field surrounding the earth, due to its permanent magnetism, and it therefore becomes essential to study carefully the data that they can give. Prof. Bigelow's instrument is for this purpose, and will be sent to Alaska this autumn, where the aurora is seen in the best conditions.

THE KOUSMINE DIFFUSION BATTERY.

The diffusion battery of M. Kousmine has been much used in Russia. By making use of the phenomenon of diffusion, M. Kousmine has succeeded in overcoming the increase in internal resistance of the bichromate of potash battery due to the formation of crystals on the positive electrode. The positive carbon electrode consists of four strips attached to the lid of the battery. The negative zinc electrode consists of a circular grating resting on the bottom of the battery. By means of a funnel a 15 deg. Beaumé solution of sulphuric acid is introduced until it just reaches the lower end of the carbon strips. A 6 to 7 per cent. solution of bichromate of potash is next introduced. The two liquids do not mix on account of the great difference in their densities. When the battery is short-circuited it is easy to see that chemical action only takes place close to the lower end of the carbon strips, which are gradually surrounded by a violet ring two or three millimetres deep. Above this region the bichromate solution retains its original color. The bichromate solution being very weak, the chromic crystals dissolve as soon as they are formed, and the positive electrode is not covered by a deposit as in other batteries. The solution of these crystals, having a greater density than the surrounding liquid, falls to the bottom. The sulphate of zinc also falls to the bottom of the cell, causing more sulphuric acid to rise. A cell having the following dimensions has been tested by a committee of experts: Height, 20 centimetres; diameter, 15 centimetres; surface of zinc, 176 square centimetres; bichromate solution, 6 per cent.; sulphuric acid, 15 deg. Beaumé. The committee reported that after having been circuited for 8½ hours on an external resistance of .32 ohm, and then left on an open circuit for 10½ hours, the cell continued to work for 4½ hours, when the circuit was again closed, and that it gave during 18 hours 36 ampere-hours for an expenditure of 48 grammes of zinc.

Mr. Carl Young has been appointed superintendent of the Williamsport, Pa., Passenger Railway Company.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

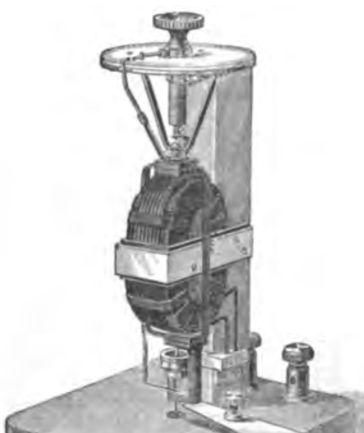
Persistency is a main element of success in advertising.

QUEEN'S NEW TYPE OF SIEMENS' ELECTRO-DYNAMOMETER.

SIEMENS' electro-dynamometer is an instrument too well-known to electricians to require any description. The ease with which it may be standardized, even by those not familiar with instrumental work, its constancy and freedom from variable elements, and its immediate applicability to the measurement of either direct or alternating currents, have placed it in the hands of all those requiring to make accurate measurements of such currents. With a view to improving certain weak points in the type commonly made, as well as to producing a more convenient and perfect instrument, Messrs. Queen & Co., of Philadelphia, have designed a form of electro-dynamometer shown in the accompanying illustration.

In this type the coil hangs by a small hardened steel centre in a cup centre of highly polished agate. The coil, hung in this way, is free from any perceptible friction and the sensitiveness of the instrument is very greatly increased. To reduce the moment of inertia of the suspended coil, an index made of light aluminum wire has been used instead of the usual heavy brass index. Just below the agate a small brass pin extends downward and fits into a cylindrical opening, a trifle larger, in a rubber block clamped to the upper part of the movable coil; hence, by releasing the spring shown on the base the coil is lifted from its agate and held tightly, so that, despite the roughest handling in transportation, the jewel cannot be broken, while the steel centre will accurately reseat itself in the agate, owing to the guidance of the pin, when the the spring is depressed by means of its screw. Instead of two uprights, as in the Siemens' made type, Queen's design employs but one, thus considerably lightening the instrument, as well as making its working parts more accessible. The binding posts are placed at the rear of the instrument instead of in front, thus getting the connecting wires out of the way.

The instrument is thus far wound to but two ranges, viz., from 2-10 to 20 amperes, and from 1 to 60 amperes. Other sizes will be made for higher and lower ranges of current as soon as possible. Each instrument is furnished with two sets of windings; thus in the 20-ampere type one set allows measurements to be made



QUEEN'S IMPROVED ELECTRO-DYNAMOMETER.

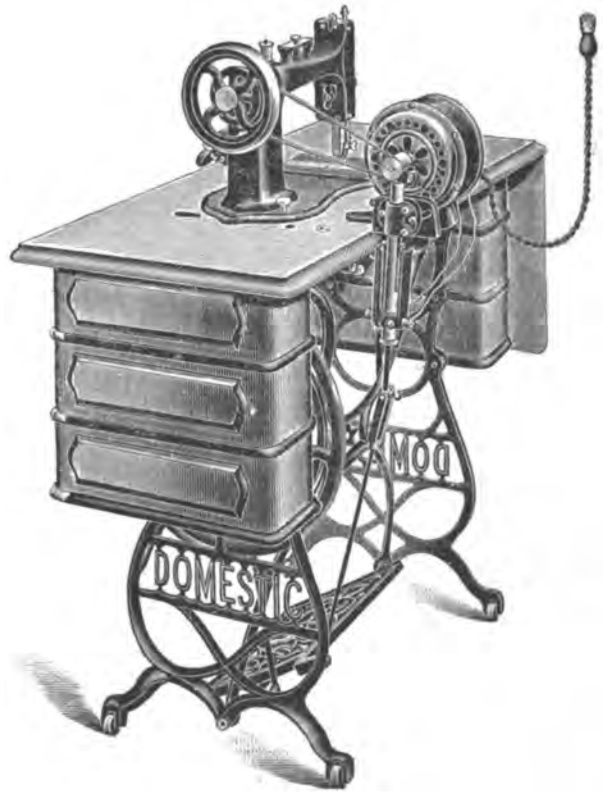
varying from 2-10 to about 4 amperes, while with the other set the range extends from about 1 to 20 amperes.

The whole instrument is finely finished in polished mahogany and lacquered brass and copper. The dial is of opal glass and graduated in 400 equal divisions. These instruments are also being made enclosed in glass cylinders, and with a brass instead of wood support, a silvered instead of opal dial, and otherwise more handsomely finished.

MR. W. E. CORSON, engineer of the Haverhill, Mass., electric light plant has resigned to accept a more lucrative position in Boston.

THE EMERSON ALTERNATING CURRENT MOTOR FOR SEWING MACHINES.

THE accompanying illustration shows an alternating current motor for sewing machines, now being placed on the market by the Emerson Electric Mfg. Co., St. Louis. In applying the motor to a sewing machine the fly-wheel and connecting-rod are removed, and in place thereof is substituted a simple electro-mechanical



EMERSON ALTERNATING MOTOR WITH SEWING MACHINE.

regulating device, which is actuated by foot-pressure on the treadle, which is connected to the regulating device by means of a connecting-rod. Various speeds are given to the machine by pressing the treadle down. The farther down it is pressed, the greater is the speed of the machine. The device controls the speed very sharply, it being possible to bring the machine to a dead stop from full speed almost instantaneously.

The motor is of the same size—$\frac{1}{8}$ h. p.—as the fan motors which they have been selling during the summer, but is wound somewhat differently.

The device is also applicable to dentists' and jewelers' purposes and other light work.

THE NEW PROCESS RAW HIDE COMPANY.

THE above company was recently the recipient of the following letter, which speaks for itself:

THE NEW PROCESS RAW HIDE COMPANY,
Syracuse, N. Y.

Gentlemen:

We have yours of the 13th instant asking our experience with your raw hide pinions.

Our large orders for your pinions in the fifteen months past, amounting to thousands of dollars, must speak pretty well for your goods, and the satisfaction they are giving. A number of our best customers use your make of pinions exclusively, and they have pronounced themselves as being satisfied that the Patent Raw Hide Pinion is by far the most economical and satisfactory. On the Wightman single-reduction motor we have adopted your pinions as being the most satisfactory way of transmitting the power from armature to car axle.

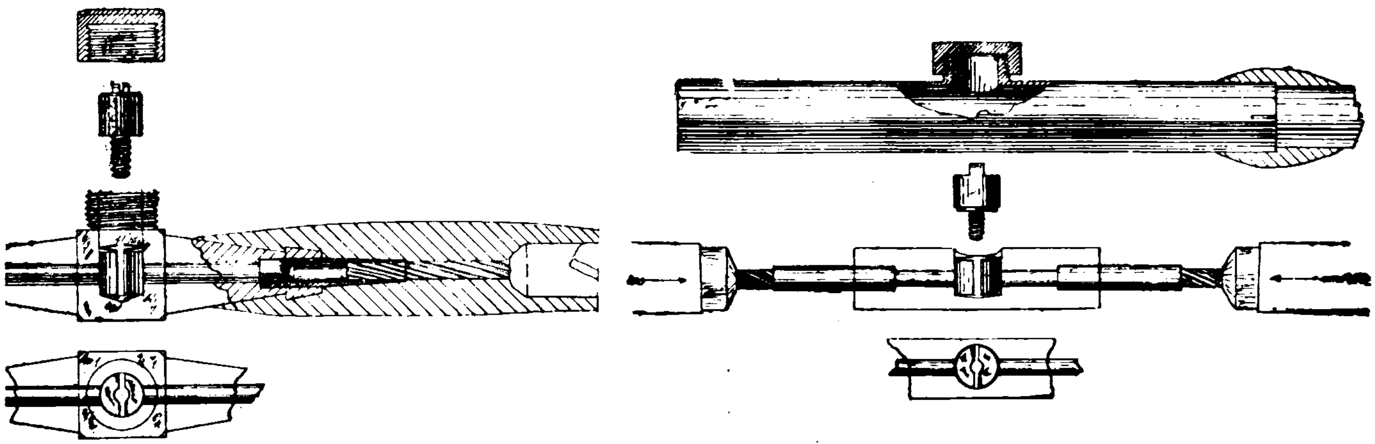
Respectfully yours,
THE WIGHTMAN ELECTRIC MFG. CO.

SCRANTON, PA., August 17, 1891

MR. L. R. EMMET has been appointed engineer of the Central District of the Edison General Electric Co., in the place of Mr. Dugald C. Jackson, who becomes professor of electrical engineering at the University of Wisconsin.

CUTTER'S CONDUIT CONNECTOR.

In operating underground electric circuits the problems connected with proper insulation and the location of faults are somewhat different from those met in overhead lines, and a number of new devices have been brought out to solve these problems. Thus any leakage in an underground cable is apt to be more serious than in an overhead line, and as the leakage resistance may be very high in proportion to the resistance of the conductor, the ground may be hard to locate. So with an underground arc light circuit winding through many streets, it would be a hard task to locate a fault without disconnecting different sections. For this purpose George Cutter, of Chicago, has brought out his conduit connector, which enables the different sections to be quickly separated for testing by simply removing a screw plug. When this is replaced, it forms a good connection and the joint is closed up water-tight.

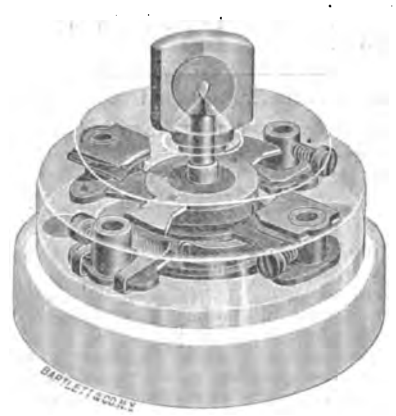


Cutter's Conduit Connector.

The cut shows two forms of this connector. The first has the two metal terminals imbedded in a hard rubber shell and a cap of the same material closes the opening. The ends of the cable are soldered into slotted sleeves, and a heavy wrapping of rubber tape covers the joint. This form is used with rubber wires, while with lead cables the parts are placed in a brass sleeve which slips over the lead coating and is soldered to it. In either case the whole is sealed tightly and yet allows of readily disconnecting the wires. The good points of such a connector can be seen at a glance, and it may be added that it is used on the underground arc light circuits operated by the city of Chicago.

THE HART SWITCHES.

The Hart double-pole switch, which has just been put upon the market by the Hart & Hegeman Manufacturing Co., of Hartford, Conn., possesses all the merits of the Hart single-pole switches, viz., durable construction, quick rotary movement in one direction; positive action, the switch-plates being locked in position until they are under the control of the actuating spring; large contact surfaces and unusually long break for the diameter of switch. The length of break in the fifteen ampere double-pole switch, illustrated herewith, is three inches, the outside diameter of base being two and seven-eighths inches. The length of break increases with the size of switch until in the one hundred ampere switch it is six and one-half inches. The one hundred ampere switch is mounted on a slate base six inches square and is provided with clamping devices or binding posts which will take up to No. 0000 B. & S. wire, or flat bar up to three-eighths by three-quarter inches, and is so arranged that the wire or bar may be brought down the face of the switchboard, or enter clamps from back of board, without bending it in either case. This feature facilitates neat and rapid construction. The long break and quick action allow the double-pole switches of all sizes to be used on railway or power circuits of five hundred volts, and on primary alternating circuits of one thousand volts.



Hart Double Pole Switch.

THE ORANGE MACHINE AND REPAIR WORKS.

When the Standard Cash Register Co. went out of business some time since, the machinery, tools, etc., were bought up by Messrs. C. E. Hathaway, H. L. Edge and Wm. Edge, who formed a manufacturing and repair business under the name appearing at the head of this article. Light machinery of various kinds is built and it is intended to shortly undertake the manufacture of small dynamos, motors, and electrical appliances.

PHILADELPHIA NOTES.

Messrs. Walker & Kepler are installing a plant for the John B. Stetson Co., 4th Street and Montgomery avenue, consisting of two 500 and one 250 light Edison dynamos; also an Edison arc light dynamo with twenty 2,000 candle power capacity.

The Lamokin Car Works, of Chester, Pa., are turning out electric cars as rapidly as their present factory will permit. They have just completed 20 cars for the Metropolitan Street Railway Co., of Denver; 60 cars are now being constructed for the Citizens' Street Railway Co., of Memphis, Tenn. The Rock Creek Railway Co., of Washington, D. C., will also be supplied with cars from these shops.

Messrs. Thomas H. Dallett & Co., manufacturers of the Billberg motors and generators, have opened an office, 126 Liberty street, New York, for the sale of their motors and dynamos, and also the Triumph Compound Engines, for which they are agents. This firm have recently built a large factory at the corner of York and Sedgley streets, which has been filled with the latest improved machinery. All of this is being used, and an addition to their works is contemplated.

The Heisler Electric Light Co. are installing a 500 16 c. p. light plant at West Toronto Junction, Canada, and also a 600 16 c. p. light plant at Waterloo, Ill., through their agents, the Interstate Complete Electric Construction Company, of St. Louis, Mo.

Mr. G. A. Wilbur, agent for the Fort Wayne Electric Company, has installed five 60 arc light Wood dynamos for the Southern Electric Light & Power Company, of this city, and a 60 arc light plant for the People's Electric Light Company, of York, Pa.

Messrs. J. W. Parker & Co., Philadelphia agents for the Ball Engine Company, have just sold a 80 h. p. engine to the Citizens Electric Illuminating Company, of Pittston, Pa.

Mr. G. A. Wilbur, of this city, has the contract from the People's Electric Light Co., of York, Pa., for a 60 Wood arc light plant.

The Southern Electric Light Plant and Power Co., of this city, is installing five Wood arc light dynamos.

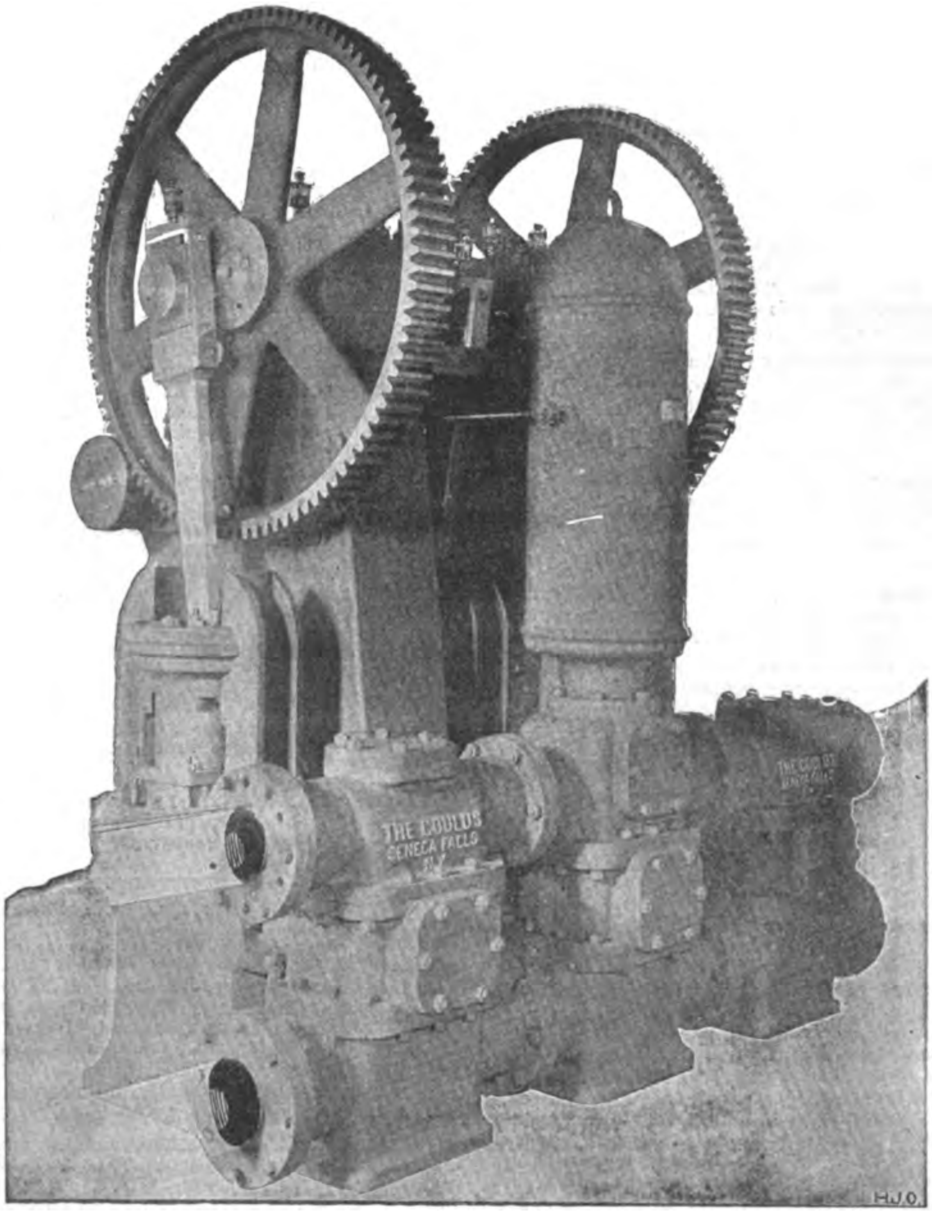
THE TRIPLEX ELECTRIC PUMP.

The Triplex or three-cylinder pump, made by The Goulds Manufacturing Company, of Seneca Falls, N. Y., and with offices at No. 16 Murray street, N. Y. City, possesses important advantages in combination with electric motors. The pump offers absolutely even and unvarying resistance to the motor under all conditions, and consumes but a minimum of power in friction of parts. Careful tests of the outfit complete have shown a high efficiency. The three-throw crank shaft, in the stroke of which there is no dead centre, prevents jerky motion and vibrations.

In villages or cities where power can be had from electric light or power circuits, electric pumping offers relief from the discomforts of insufficient or hard and unfit water supply, and the hardly lesser trials of disagreeable, noisy and dangerous pumping engines in vogue.

The Triplex electric pump will take water from any source, as spring, cistern or well, and force to upper supply tanks of residences, shops, warehouses, buildings, etc., or force city water to a higher point than its own pressure will carry it, as is often the case in the more elevated city districts or in very high buildings.

In factories, such as large cotton mills, woollen mills, steel works, etc., and, in fact, in any large establishment where work is distributed over a large territory, the employment of electrical transmission of energy for pumping can be used to great advantage. The steam pump is now in common use for that purpose. Steam is generated in the boiler and transmitted through long lines of pipe to pumps, where the work of pumping is performed. It has been found by actual experiment and demonstrated repeatedly that these direct-acting steam pumps are most wasteful consumers of steam, using in the neighborhood of 25 pounds of coal per horse-power per hour. With electrical pumping outfits all this is changed.



The Goulds Triplex Electric Pump.

One of the most troublesome questions in mining operations is the disposal of water. By the introduction of electricity for underground work the problem is greatly simplified. The necessity for long lines of steam pipe is removed, and in the place of hot steam pipes spreading dry rot in the vicinity, a small copper wire is suspended from wall or ceiling; or the current may be taken from the trolley wire, if the mine is equipped with an electric haulage plant. In some cases, where transmission from the surface by steam or compressed air was utterly impracticable, and an underground steam plant seemed necessary, it has been found that the cost of excavating and drilling holes for the chimneys would exceed the total cost of the electric pumping plant.

The pumps are adapted so as to be readily combined either by gearing or belting with all of the standard electric motors, and a large number of them are already in use.

DEATH OF G. MURRAY GRIFFITH.

We regret to record the death of Mr. G. Murray Griffith, a member of the Philadelphia engineering firm of W. S. Griffith & Co. His death occurred on August 28.

STARTING THE ELECTRIC ROAD AT ESCANABA, MICH.

Escanaba, Mich., is a thoroughly progressive town with a population of 8,000. Its streets are wide and well paved and from its immense ore docks, perhaps the largest in the world, large shipments are made, which makes the tonnage greater than from any other part of the country, except New York. Under such conditions, Escanaba could not, of course, permit its sister towns to surpass it in facilities for rapid transit and nothing less than the latest electrical equipment would satisfy the present desires of the community. The road, which was recently completed and formally opened for traffic on September 13, certainly reflects credit on its owners and others concerned in its construction. It extends from the railway station, on Stephenson avenue, about three-quarters of a mile, thence through Ludington street for a distance of one and a half miles. The latter street is the main business thoroughfare, and is lined throughout its entire length with the principal stores of the city.

At the opening of the road the scenes which have become so familiar were repeated. Crowds of passengers, enthusiastic citizens and delighted owners all testified their satisfaction with what is fast being recognized as the only method of rapid transit, suitable alike for cities or villages. On examination of the road and its construction, it was seen to be one of the most carefully constructed in the West. The track is laid with 45 pound Johnson girder rails, and the rolling stock consists at present of two Pullman cars mounted upon Hubbard trucks, manufactured by the McGuire Manufacturing Company. The electrical equipment of each car consists of one 20 h. p. single-reduction Westinghouse motor. All the line material was furnished by the Electric Merchandise Company, Chicago, and the overhead work presents a neat and handsome appearance. The cars will be heated during the coming winter with the Burton electric heater, thus making the system purely electrical. The tracks were laid under the care of James B. Moran, who is to be manager of the road, and the installation at the power house, together with the construction of the overhead work, was in charge of Mr. J. F. McBeth.

ST. LOUIS EXPOSITION NOTES.

THE EMERSON ELECTRIC MANUFACTURING CO. make a very complete display of their goods. Their alternating current motor is shown in operation, driving sewing machines and jewelers' lathes. The sewing machines attract much attention. Their new model Bagnall live trolley crossing is shown in position. The Bagnall fuse switch, the Emerson improved cross-over and strain insulators are shown among their railway appliances, and also their ideal switch-back for arc light switchboards, and a number of new model spring-clip cut-outs.

THE SHULTZ BELTING CO. have a working display showing the manufacture of their patent woven leather link belting. They also display samples of their well-known raw-hide belting, one roll of which is quite noteworthy, being 72 inches wide and 154 feet long, and weighing 2,000 lbs. This belt was made for the St. Louis and Suburban R. R., which is now being changed from cable to electric power.

THE LACLEDE POWER CO. show a 80 h. p. electric power plant in operation. A 35 h. p. Westinghouse engine drives a 30 K. W. 500 volt C. & C. generator, which supplies current to a 20 h. p. C. & C. motor in the *Post-Despatch* exhibit in a distant part of the building. The 20 h. p. motor is used to drive a printing-press. Current is also supplied to a number of smaller motors about the building.

W. D. BOYCE & CO., who have lately taken the agency for the Porter-Allen engine, have one of 100 h. p. in operation driving a 250-light Edison, and 180-light Standard dynamo, supplying lights to various parts of the building. This well-known engine is meeting with much favor in the West.

THE ST. LOUIS ELECTRICAL SUPPLY CO. have a large display of their well-assorted goods—Crocker-Wheeler, Edison, Emerson, and Wagner fan motors, Edison-Lalande, Crosby and other batteries, wires and cables, and a varied assortment of general merchandise arranged in a very attractive manner.

THE ST. LOUIS IRON AND MACHINE CO. have one of their 100 h. p. Corliss engines in operation, driving a line of shafting in the basement. The engine has some novel improvements in valve-actuating devices and dash pots, which render its operation almost noiseless.

THE HEINE SAFETY BOILER CO. have one of their well-known boilers set up in position with one side wall of the furnace removed so as to show the special features of the boiler and furnace setting.

THE ROSE ELECTRIC LIGHT SUPPLY CO. have a 350-light Ft. Wayne Jenney dynamo in operation, supplying lights to various exhibitors in the building. Power is supplied by a Russell engine.

THIS season no special inducements were offered by the Exposition Association to electrical manufacturers and dealers, and the electrical exhibit is therefore entirely local.

C. A. WOLFRAM makes a display of electric bells, annunciators, lamp fixtures, fans, and other merchandise.

THE ELECTRO-DEPOSITING CO. show the process of electroplating by means of dynamo currents.

NEW ENGLAND TRADE NOTES.

THE THOMSON-HOUSTON ELECTRIC COMPANY, lighting supply department, have just published a most comprehensive and carefully-compiled catalogue of electrical supplies. The book contains 200 pages, is bound in hard cardboard, and is profusely illustrated. It is divided into three sections, part 1 containing articles manufactured solely by the Thomson-Houston Electric Company, such as transformers, switchboards, lamps, meters, indicators, switches, commutator brushes, arc lamps and hoods, carbons, cut-outs, rosettes, sockets, etc. Part 2 contains miscellaneous supplies which the Thomson-Houston Company do not manufacture, such as insulated wires and cords, tapes, hard-rubber tubing, connectors, cleats, insulators, insulated joints, brackets, lamp guards, lamp shades and reflectors, mouldings, mast-arms, poles, lamp hangers, and tools. Part 3 is devoted entirely to tools for electrical construction, such as magneto-bells, speed indicators, callipers, wire gauges, tongs, pliers, screwdrivers, ratchet braces, augers, saws, hacksaws, files, drills, chisels, hammers, wrenches, pole-diggers, picks, shovels, spades, etc. The volume is very complete, and the cuts are excellent, the whole being compiled in so careful a manner that it must become of immense value to every electric light man who is fortunate enough to possess one.

JEROME REDDING & COMPANY.—Messrs. Jerome and Harvey Redding have separated from the Redding Electric Company, and have formed the above company, with headquarters at the old address, 48 Hanover street, Boston. They will continue to manufacture all the old specialties, consisting of general electrical household supplies. The disque battery will continue to be a strong feature of their business, and they are bringing out a number of new specialties, of which particulars will be given later.

THE GERMANIA ELECTRIC COMPANY, of Boston, are commencing to manufacture their new Germania direct incandescent dynamo. The patents controlling the inventions covering this machine are the well-known Lahmeyer patents, under which the Continental Dynamo Company, of New York, formerly operated. This dynamo is in successful operation in a large number of representative buildings, amongst which are the Cotton Exchange, New York; the Belvedere House, New York; the John Hancock Building, Boston, etc. The Germania Company are now manufacturers of dynamos, transformers, incandescent lamps, sockets, shade-holders, and other electric materials, and are thus well equipped for general electrical manufacture, construction and installation.

THE GOULD & WATSON COMPANY.—The West End Street Railway Company, of Boston, in the extension of their electric system of street railways, have placed very large orders with the Gould & Watson Company, of Boston, for various overhead line material. This order embraces strain insulators for span wires, line insulators for trolley wires, and guard wire insulators of an entirely new pattern, possessing extraordinary strength. They are also supplying clips, anchor ears, splice ears, and other necessary material. It is gratifying to the Gould & Watson Company that their factory is as busy as possible, turning out all kinds of insulators for railway work, and moulded mica appears to be quite a favorite after several years' hard test.

H. N. BATES & COMPANY, of Boston, have just completed the equipment with shafting, clutches, pulleys, etc., of the station of the Augusta, Gardner, and Hollowell Street Railway, at Hollowell, Me., and the station of the Woonsocket Electric Light and Power Company, at Woonsocket, Mass. They have just received the contract to furnish shafting, clutches, pulleys, etc., for the Fall River Electric Light Company, at Fall River, Mass., and they have a big contract on hand for the Kearney Cotton Manufacturing Company, at Kearney, Neb. This order will include, in addition to pulleys, hangers, shafting, and clutches, the whole electric plant, consisting of a 500 light dynamo, fixtures, lamps, and the work of installation.

THE REDDING ELECTRIC COMPANY have been reorganized, and Mr. John C. Holman has been appointed president. The board of directors now stands as follows: John C. Holman, president; H. B. Stanwood, treasurer; H. M. Nicholls, secretary, and S. C. Whipple. The business of the company is steadily increasing in electric light and general electrical supplies.

THE GERMANIA ELECTRIC COMPANY, of Boston, have appointed Mr. B. B. Stoddard to represent them in Philadelphia, and he will have his headquarters at 505 Girard Building, in that city. Mr. Stoddard has been connected with the Woonsocket Electric Machine and Power Company for several years, and has had a wide experience in the use of all kinds of incandescent lamps.

TROPICAL AMERICAN TELEPHONE COMPANY, of Boston, has been allowed three important patents in telephones and magneto bells, embodying many new features.

WESTERN TRADE NOTES.

THE CHICAGO ELECTRIC MFG. CO., 73 West Jackson street, Chicago, have their factory crowded with specialty work and testing instrument manufacture. Mr. J. D. Claghorn, the popular manager of the company, has been compelled, through ill health, to take a long vacation, and will probably spend the winter in Southern Nebraska. The appointment of a superintendent to assist Mr. Irving Usner, the treasurer of the company, in its management will shortly be made, and meanwhile Mr. Usner is looking after the company's large business.

CHANDLER & LITTLEFIELD, manufacturers' agents, Marine Building, Chicago, have sold a 70 h. p. Foote regulator to the Edison Company, of Appleton, Wis. In addition to being the Western agents for the T. M. Foote Regulator Co., of Boston, they carry a general assortment of machinist's and engineer's supplies, and are Western agents for the Lexington Gear Works and the Providence Steam Trap Co.

THE POND ENGINEERING CO. has just contracted, through its Chicago office, to furnish two 60 horse-power Armington & Sims engines, with foundation boxes, to the Gas Works in Chicago. One of them goes into the north station of the People's Gas Light and Coke Co., and the other into the south station of the Chicago Gas Light Co. Both will be used for driving blowers.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE

Electrical Engineer.

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THE LOCALIZATION AND REMEDY OF TROUBLES IN DYNAMOS OR MOTORS.—III.

BY

Francis B. Crocker and S. S. Wheeler.

HEATING IN DYNAMO OR MOTOR.

General Instructions.

THE degree of heat that is injurious, or even objectionable, in any part of a dynamo or motor is fortunately very easily and quite definitely determined in ordinary practice. All that is necessary is to place the hand on the various parts, and if it can remain without discomfort the heat is entirely harmless. But if the heat is unbearable for more than a few seconds the safe limit of temperature has been passed, and it should be reduced in some of the ways that are given below. If the heat has become so great as to produce an odor or smoke, the safe limit has been far exceeded, and the current should be shut off and the machine stopped immediately, as this indicates a serious trouble, such as a short-circuited coil or a tight bearing. The machine should not again be started until the cause of the trouble has been found and positively overcome. Of course neither water nor ice should ever be used to cool electrical machinery, except possibly the bearings in large machines, where it can be applied to the bearings as a cooler without danger of wetting the other parts.

The above simple method will answer in ordinary cases, but, of course, the sensitiveness of the hand differs, and it makes a very great difference in the feeling whether bare metal or cotton-covered wire is touched. Hence, for accurate results, a thermometer should be applied and covered with waste or cloth to keep in the heat. In proper working the temperature of no parts of the machine should rise more than 40° C. or 72° F. above the temperature of the surrounding air. If the actual temperature of the machine reaches boiling point, 100° C. or 212° F., it is seriously high.

It is very important in all cases of heating to locate correctly the source of heat in the exact part in which it is produced. It is a common mistake to suppose that any part of a machine which is found to be hot is the seat of the trouble. In every case all parts of the machine should be felt to find which is the hottest, since heat generated in one part is rapidly diffused throughout the entire machine. It is generally much surer and easier in the end to make observations for heating by starting with the whole machine perfectly cool, which is done by letting it stand for one or more hours, or over night, before making the examination. When ready to try it, run it fast for three to five minutes, then stop and feel all parts immediately. The heat will then be found in the right place, as it will not have had time to diffuse from the heated to the cool parts of the machine. In fact, after the machine has run some time any heating effect will spread until all parts are nearly equal in temperature, and it will then be almost impossible to locate the trouble.

HEATING OF ARMATURE.

1. Cause.—*Excessive current in armature coils.* Symptom and Remedy the same as Sparking No. 1.

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2. Cause.—*Short-circuited armature coils.* Symptoms and Remedies the same as Sparking, No. 5.

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3. Cause.—*Moisture in armature coils.*

Symptom.—Armature requires considerable power to run free. Armature steams when hot, or feels moist. This is really a special case of No. 2, as moisture has the effect of short circuiting the coils through the insulation. Measure insulation of armature.

REMEDY.—Dry the armature in a warm, but not hot, place. This may be done very neatly by passing a current through the armature, which should be regulated so as not to exceed the usual armature current.

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4. Cause.—*Foucault currents in armature core.*

Symptom.—Iron of armature core hotter than coils after a short run, and considerable power required to run armature when field is magnetized and no load on armature. This may be distinguished from No. 2 by absence of sparking and absence of excessive heat in a particular coil or coils after a short run.

REMEDY.—Armature core should be laminated more perfectly, which is a matter of first construction.

HEATING OF FIELD MAGNET.

1. Cause.—*Excessive current in field circuit.*

Symptom.—Field coils too hot to keep the hands on.

REMEDY.—In the case of a shunt-wound machine decrease the voltage at terminals of field coils, or increase the resistance in field circuit by winding on more wire or putting resistance in series. In the case of a series-wound machine, shunt a portion of, or otherwise decrease, the current passing through field, or take a layer or more of wire off the field coils, or rewind with coarser wire. This trouble might be due to a short circuit in field coils in the case of a shunt-wound dynamo or motor, and would be indicated by one pole-piece with the short-circuited coil being weaker than the other; one of the coils would also probably be hotter than the other; but this can only be remedied by rewinding short-circuited coil. Measure resistance of field coils to see if they are nearly equal. If the difference is considerable (*i. e.* more than 5 or 10 per cent.) it is almost a sure sign that one or both coils are short circuited or double-grounded.

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2. Cause.—*Foucault currents in pole-pieces.*

Symptom.—Pole-pieces hotter than coils after a short run. The pole-pieces being bare metal and coils being covered, when making comparison it is of course necessary to keep hand on coils some time before full effect is reached, and even then it is reduced.

REMEDY.—This trouble is either due to faulty design and construction, which can only be corrected by rebuilding, or else it is caused by fluctuations in the current. The latter can be detected, if the variations are not too rapid, by putting an ammeter in circuit, or rapid variations may be felt by holding a piece of iron near the pole-pieces and noting whether it vibrates. A direct current does not usually vary enough to cause this trouble, but in the case of an alternating current it is necessary to use laminated fields to avoid great heating, and the ordinary arc currents fluctuate enough to cause some trouble in this way.

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3. Cause.—*Moisture in field coils.*

Symptom.—Field-circuit tests lower in resistance than normal in that type of machine, and in the case of shunt-wound machines the field takes more than the ordinary current. Field coils steam when hot, or feel moist to hand.

REMEDY.—Dry the field coils in a warm but not hot place. This may be done simply by passing a current through the field coils, which must be regulated so as not to exceed the usual field current.

PIPING ELECTRICITY—A TALE FOR WIRE BUYERS.

BY

Albert Scheible

THERE was once a place—perhaps Jules Verne can tell you its name—where the natives had learned to produce a certain mysterious fluid, and could make this medium do their many chores. Indeed, so useful was this fluid that it was thought best to pipe some of it to remote parts of the town where many would want its help. But it was found quite a problem to keep the mysterious fluid from oozing out and choosing paths of its own, so that it was necessary to produce as much more of the fluid as was lost on the way. Besides, this leakage created quite a prejudice in the minds of many who did not know that this fluid was so truly docile. So some set out to make pipes which would more completely restrain the subtle fluid, and they succeeded in a varying degree in producing such an article. Indeed, a few managed to make very good pipes, and some which would save so much leakage as to pay for their higher cost in a short time.

Now when such pipes grew in demand and many, many feet of them were used month after month, there were others who sought to supply the fluid-makers with their wares. So they figured this way, and that, but always found that no salable pipe could be made for less than a certain amount per foot, and it seemed evident that the users would buy it (as they would use it) by the unit of length. Then there was more discussion and deliberation, and some experimenting. Bye and bye it happened that some makers offered their make of tubes for sale by the pound, and claimed that this made their pipes really cheaper than the thoroughly tested ones, which were sold by the foot. And they found many buyers who did not stop to look into the lasting quality of the tubes, but who would buy whatever required the least outlay. Then when they renewed their pipes—for most of these did not last many months, and their breaking down was often quite annoying—they would buy some more by weight at the same "bargain figure." Only here and there some practical man would examine some of the various pipes, and would figure out that it was really far cheaper to use the tubing which was sold by the foot at what seemed a much higher price. For it was remarkable how clearly every leak would show its effect in the coal pile, and the coal bill came every month, while that for pipe (if it was a first-class article) needed no repetition. Gradually there were more and more who knew that much of the material in the "cheap-by-the-pound" pipes was put in more to add to the weight than to keep the fluid within bounds. Indeed, some of the materials used were anything but suitable for this purpose, and, in order to overlook these ingredients, the buyer had to have both eyes blinded by the apparently low price. Still, many such tubes were nicely polished and decidedly pretty when new; indeed some were quite serviceable as long as neither water, nor the hot sunshine, nor strong fumes could get at them, and as long as they were not touched by ungloved hands.

Since then many months have passed; the old prejudice against the mysterious fluid is dying out, and mile after mile of the tubing is in steady use. Yet a few weeks ago when I visited this place I found that the old methods of the pipe-makers had not been outgrown, and that the number of different brands sold on the hay-scale plan was larger than ever. To be sure, many of these are replaced every month by some of the kinds which are sold, not for their light weight, but for their thorough and lasting qualities. It is even claimed that the first of these carefully-made pipe-lines is still in use. Yet I found many buyers who seemed to think a pound of rubber worth little, or no, more than a pound of wax or lead paint when used as a material for a pipe.

Perhaps there is some truth in what one of the residents—a bright engineer who looked thrice before he bought an article, and judged it by its true merits—told me about a large pipe-buyer. He said that this wise man was so impressed with the idea of buying these tubes by the pound that he had applied this principle to nearly everything about the station, and now had his belts, oil and carbons weighed out and paid for accordingly. And is not this just as reasonable?

I also noticed the coal-dealers all seemed to favor the "cheap-by-the-pound pipes," and so did many of the supply men. I remonstrated with one of the latter for selling such wares, but he merely smiled, slapped his hand against his pocket half full of coin and then whistled the familiar refrain, "Still there's more to follow." I turned in disgust, but only to see the station manager across the way lengthen his face as he scanned the last coal bill. O Father Time, pipe us some progress!

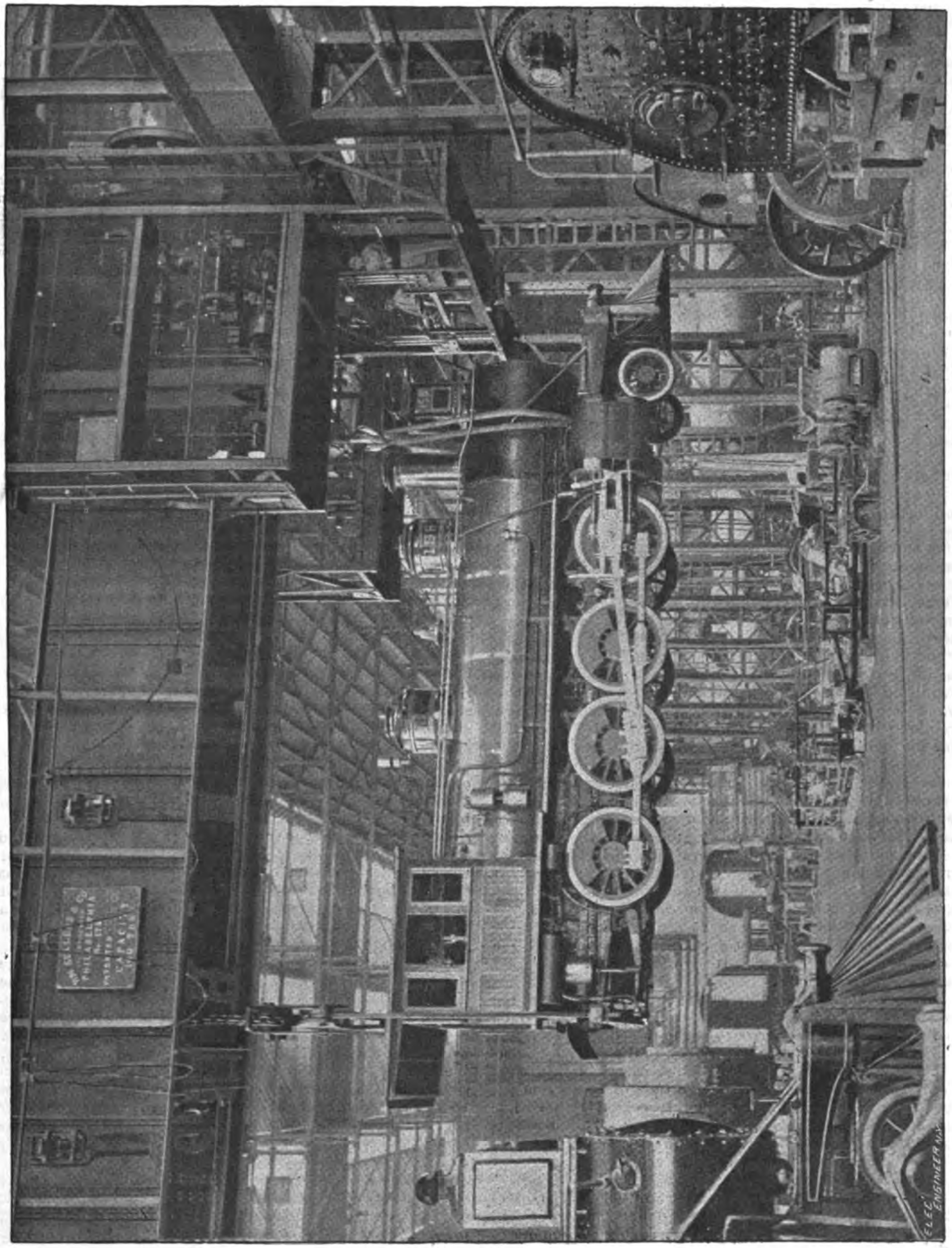
ELECTRIC CRANES AT THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

MUCH has been written lately of traveling cranes and the possibilities and advantages of operating them by electricity, but up to the present no details have been made public of the electric cranes at the Baldwin Locomotive Works, in Philadelphia, which comprise probably the most powerful cranes of this type thus far constructed.

There are there two large traveling cranes, each of 100 tons capacity, running side by side in the new erecting shop lately built by this company. The cranes proper were built by Messrs. Wm. Sellers & Co., of Philadelphia, who are well known as builders of this class of machinery, and it was at their suggestion that electricity was adopted as a motive power.

On each crane there are two 40 h. p. Westinghouse constant potential, shunt-wound motors, geared independently to the driving machinery by vertical belts; the motors being mounted on the extreme top of the bridge of the crane. The motors run in one direction at all times, and the reversing of the crane is accomplished through friction clutches, and through these clutches the power is distributed to the various parts of the crane for moving the bridge, moving the lifting trolleys and hoisting the load.

Each crane is provided with two 50-ton lifting trolleys, that is, each trolley is capable of lifting fifty tons, and the



100-Ton Traveling Electric Crane at the Baldwin Locomotive Works, Philadelphia.

power is conveyed to these trolleys by a square shaft running the entire length of the bridge inside the girders.

The accompanying engraving shows the method employed in lifting a locomotive; a rope is placed around the front end of the engine, and a large iron frame is placed on the rear end, and the two trolleys are worked simultaneously, although either one can be stopped and the other raised or lowered at the discretion of the man who is operating the crane. The large hooks and chains on these trolleys are very massive and move rather slowly, and are used only for lifting the very heaviest loads; but a 5 h. p. quick hoist has been placed on the far lifting trolley for lifting loads under one thousand pounds. This quick hoist is operated by a 5 h. p. Wenstrom motor, series wound and reversible, and is controlled from the cab of the crane. This motor and drum move forward and backward with the trolley, and it takes eight wires between the switch and the motor to give the various speeds and to change the direction of running.

The current is taken to this motor from the stationary controlling switch through a stranded cable, which hangs at the side of the crane bridge, and falls in loops as the trolley is moved toward the operator, each loop being hung from a pair of small wheels running on a steel track at the side of the bridge. This cable was made by the International Okonite Co., of New York, and is composed of eight wires, each wire being made up of seventy-two strands of very fine copper.

Both cranes move the entire length of the erecting shop and are capable of picking up at any point the heaviest locomotive that the Baldwin Locomotive Works build and disposing of it at any other point in the shop. The operation of lifting a locomotive from the far end of the shop and lowering it on the shipping track consumes about five minutes, while the same work, before the cranes were installed, used to take a large gang of men an entire night. These cranes work very smoothly. For all lighter work only one of the 40 h. p. motors is run, the other one being started only in case of necessity.

Our engraving shows a large compound locomotive in the air, weighing sixty-five tons. When this locomotive was lifted, but one of the motors was in operation. These cranes move laterally through the shop on steel T-rails, weighing 135 lbs. per yard. This rail was rolled especially for this plant and is the heaviest steel rail in use.

Besides the two large traveling cranes above described, there are in use four jib cranes operated by electricity. These jib cranes have a capacity for lifting from five to ten tons, each crane being supplied with a 5 h. p. Wenstrom slow-speed, constant-potential motor; and there are, in various parts of the shops, several other electric motors driving machine tools or lines of shafting. The current for these motors is furnished by two 80,000 watt Westinghouse constant-potential, compound-wound generators, and have an electromotive force of 250 volts. Each generator is driven by a Westinghouse compound engine, and the steam is supplied by a battery of Babcock & Wilcox boilers.

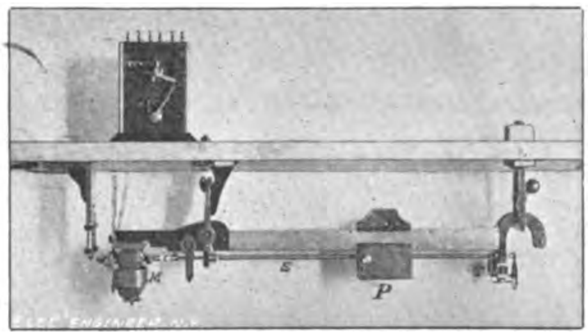
The current for the motors on the crane is taken from the overhead double-trolley line, each trolley wire being $\frac{1}{2}$ inch in diameter and laid in a groove cut in the edge of a strip of yellow pine. These strips are $\frac{3}{4}$ inch in diameter by about 3 inches wide, and are bolted through porcelain insulators to a yellow pine girder 3 x 8 inches square, hung from the roof by iron rods, and are thoroughly coated with shellac and otherwise insulated from the building. The current is taken from the trolley wires through Wheeler trolleys, each of which has four wheels, and each crane being supplied with two trolleys.

There is a considerable flow of current when the motors are working to their maximum capacity, and it was found that the two four-wheel trolleys were none too many to safely carry the current.

The entire plant has been in operation since the early part of the present year and has been satisfactory in every way. The electrical work was placed in the hands of the Equitable Engineering and Construction Co., of Philadelphia, Pa., by whom all the details were carefully worked out and put into effect, and several new features in the method of applying motors to this class of work were designed and introduced by that company in this installation.

THE DAVIS ELECTRIC TRACK SCALES.

ALTHOUGH electricity has found most important applications in railroad service in the telegraph, the working of switches and signals, and, latterly, in its direct utilization for the propulsion of cars, there are still other uses which can be found for it which will tend to still further increase the dispatch of trains. It is evident that in weighing a large number of freight cars, while accuracy is absolutely essential, rapidity in weighing is equally desirable. In seeking to fulfill both these requirements Mr. J. V. Davis, of this city, has designed the scales illustrated in the accompanying engraving. Having been weighmaster in the service of a large railroad company, Mr. Davis was thoroughly cognizant of the conditions which a track



THE DAVIS ELECTRIC SCALE.

scales must fulfill, and hence designed it with special reference to rigorous usage by unskilled handlers.

To attain this end the inventor has very ingeniously applied a small electric motor to the beam of the ordinary standard scales. The poise P is moved backward and forward along the beam by a screw rod, S, turning in ball-bearing journals; the motor M is mounted upon the shorter or inner arm of the beam, with the armature in line with, and coupled directly to, the screw. The motor is of the shunt type, with special winding, providing for instantaneous starting and stopping at full speed. It is so wound and connected with the switch terminals that when a weight is on the platform that is lighter than the last weight registered, the motor turns the screw in such a direction as to move the poise inward until it reaches the point of balance, when, by the mere act of balancing, the circuit through the armature is broken, and the fields, remaining in circuit, provide an instantaneous stop to the revolutions of the screw and the motion of the poise. When the weight on the platform is heavier than the last, the poise moves outward to a balance. It must be understood that the normal position of the poise is at the last weight recorded, and therefore, the poise has only to cover in its motions the difference between the weights of the cars; this renders the operation of weighing extremely rapid.

A series of type wheels, T, actuated by the screw are seen at the outer end of the beam. An electromagnetic device, arranged in series with the armature of the motor, prints a ticket at the instant of balancing. There is no connection whatever between a fixed and a movable part of the scale different in any way from the ordinary scale, the beam being as free to move in every way necessary to produce an exact balance and an accurate weight. In fact, it is merely a standard scale with means provided to move the poise quickly and automatically, and to provide against all mistakes.

The poise moves from end to end of the beam in four seconds, and will ordinarily come to the point of balance in $\frac{1}{4}$ to $\frac{1}{2}$ second, while the weight is recorded in plain, printed charaters at the instant when the beam is swinging in perfect balance. Furthermore, it will only weigh one car at a time, refusing to record any weight if another is touching the platform. For example, if a car comes on the platform, is weighed, and rolls partly off, leaving a pair of wheels, or any part of its weight, touching the platform, another car coming on the platform will not affect it, no weight being recorded until the first car has entirely cleared the scale. Moreover, it will not weigh a car unless all its wheels are on the platform. All these features are secured by means absolutely certain and simple in operation, and the whole machine requires no more attention to keep in order than an ordinary track scale.

A virtue of the machine, which will be appreciated by railroad men, is that its adoption will not necessitate a new installment from the pit up. Only the beam is different from the ordinary track scale, and taking the old one out and hanging the new one in its place serves to completely change to the new system. This will greatly lessen the cost and reduce the time necessary in changing, and will, no doubt, hasten the adoption of this machine.

This type of automatic scale is evidently not limited to track scales, but can be built in all sizes from counter scales up to railroad scales. We may add that Mr. Davis will exhibit his automatic electric scales at the American Institute Fair shortly to be opened in this city.

THE SCOTT-SISLING ACCUMULATOR SYSTEM.

BY

W. B. Sisling.

PRIVATE installations generally involve the use of accumulators, and to charge these the dynamo voltage must, of course, be raised some 25 per cent. above the lamp voltage.

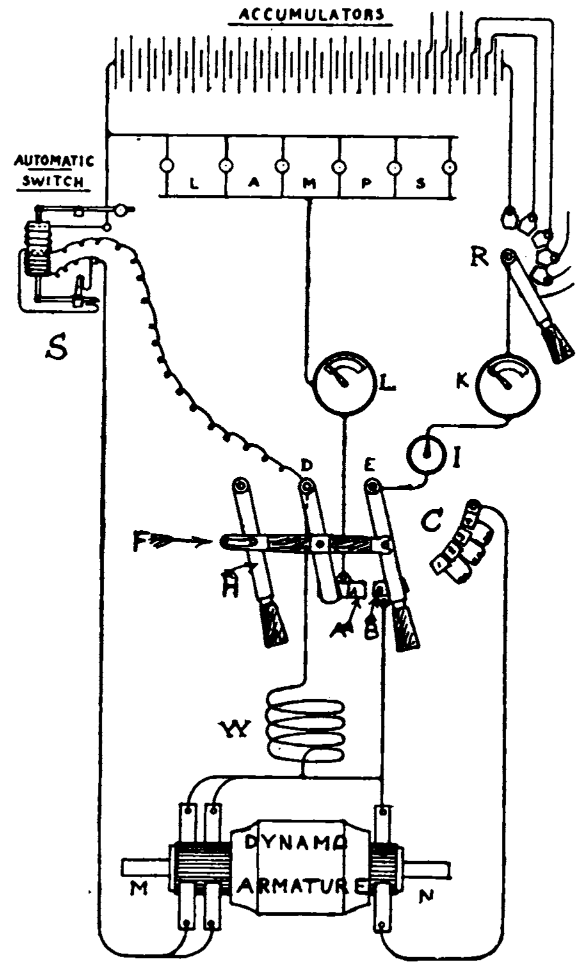
In many cases this is inconvenient and wasteful, as the dynamo must be "run up" to this increased voltage, although only a portion of the current generated may be used for charging, the remainder being required for the lamps at the normal voltage. The accompanying illustration shows an arrangement devised by Mr. W. H. Scott and the writer, which seems to overcome this difficulty, and has several features which ought to prove advantageous in a private installation.

The arrangement may be described as a compound dynamo with a small supplementary winding on its armature, connected to an extra commutator which gives a voltage usually about one-quarter of that given by the main commutator. A branch is taken from the main circuit, and connected so that the extra commutator raises its voltage by about 25 per cent. This forms the charging circuit.

The dynamo can thus be driven at constant speed and will supply constant voltage to the lamps from its main circuit, undisturbed by the increasing voltage from the cells during charging. The whole of the cells can be charged, and a large current supplied to the lamps at the same time, as this does not pass through the regulating cells. The charging can therefore be accomplished during the hours of lighting, instead of the dynamo having to be run specially during the day.

As will be seen, the dynamo armature has a main commutator, M, and an extra commutator, N. These two commutators are connected in series, either directly or through the dynamo series winding W. The switchboard contains two switches; the dynamo switch D, which connects the dynamo to the lamps, and the accumulator switch E, which connects the accumulators in either of three different ways, viz., A to the lamps alone, or B to the lamps and dynamo, or C to the charging circuit. These two switches are of the lever pattern, and are interlocked by the thrust rod F.

The handle H acts on the thrust rod so that it can only put the dynamo switch "on." To take it "off" the accumulator switch must be moved so that the accumulators are connected to the lamps alone. When the dynamo switch is put "on" the thrust rod moves the accumulator switch from A to B, thus connecting the accumulators to the dynamo in such a way that they are in readiness to assist the dynamo in supplying current to the lamps, without risk of weakening or reversing its magnetism.



THE SCOTT-SISLING ACCUMULATOR SYSTEM.

If the dynamo does not need assistance, and spare power is available, the accumulator switch may be moved further from B to C, when the dynamo will begin to charge the cells by means of its extra commutator N, without interfering with the constant voltage which is supplied to the lamps from its main commutator M.

An index, I, shows whether the accumulators are being charged or discharged, whilst an ammeter, K, indicates the amount of the charging or discharging current. A second ammeter, L, shows the current taken by the lamps, and a pilot lamp on the switchboard lights when the dynamo starts up.

By means of this arangement the manipulation is made simple, and the charging current can be adjusted to form a complementary load, thus working the plant at its maximum efficiency and shortening the hours of running.

The arrangement is in use in some private installations, the latest being one erected for Baron V. de Barreto, of Brandon Park, Suffolk, England, which is driven by an oil engine giving 11 h. p. The engine is started by the accumulators, and these also work the coil which ignites each charge in the engine cylinder. The whole arrangement seems to work satisfactorily, and without specially skilled attention, which is an important matter for country houses.

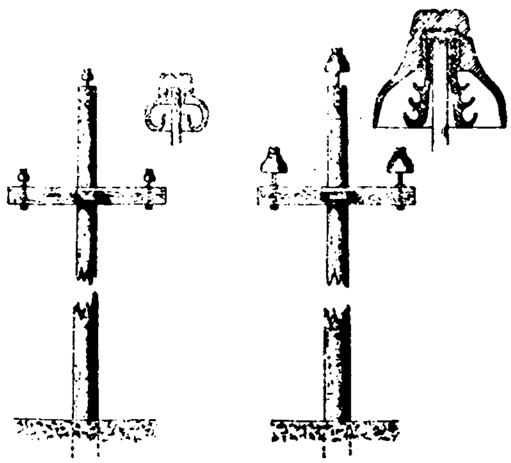
THE LAUFFEN-FRANKFORT ELECTRIC POWER TRANSMISSION.

We have on several occasions described some of the methods and apparatus employed in the transmission of electric power at high potentials from Lauffen to Frankfort, a distance of 112 miles, and our correspondent, Prof. R. O. Heinrich, has also described in detail the electrical

Fig. 1.—Switchboard at Lauffen.

system of transmission employed. There are some additional details, however, of this installation which our readers will be interested in, as they bear directly upon the question of the possibility of the transmission of alternating currents at high potentials. The dynamo machine situated at Lauffen generates a three-phase alternating current, each component of which has a pressure of 50 volts and delivers 1,400 amperes. From this machine the currents are at first led to a switchboard, which is illustrated in Fig. 1. This is equipped in the usual manner with the necessary measuring instruments, safety cut-outs and switches. From the switchboard the current is led to the transformers, which increase the potential from 50 volts to 30,000, the ultimate voltage capacity of the transformer. These transformers are placed in oil in order to obtain sufficient insulating power for the high-tension currents.

From the transformers the high-tension currents are conducted to the lines, three bare copper wires of four millimetres diameter. The line consists of poles eight metres high, placed about 60 metres apart, the number of poles employed for the whole distance being about 3,000. The copper wire employed has an aggregate length of about 530 kilometres. It has been furnished by the firm of F. A. Hesse Sons, who, in order to further this important work, have loaned it for this occasion at a very small compensation.



Figs. 2 and 3.—Poles and Insulators.

The most important point evidently in this undertaking is the proper insulation of the line. The Allgemeine Elektricitäts-Gesellschaft and the Maschinenfabrik Oerlikon, besides furnishing the generator, motor, and auxiliary apparatus and transformers, also bore the expense of the insulators—no small item. These were manufactured by the firm of H. Schomburg & Sons, Berlin. Two types of insulators are employed ; for a part of the distance that shown in Fig. 2 is used, giving but a single layer of oil between the insulator and the support, while for about one-third of the distance the type shown in Fig. 3 is used, lack of time preventing the equipping of the entire line with the latter type of insulator ; the total number of insulators reaches 9,000.

At Frankfort the high-tension circuits are conducted to three oil transformers of the type illustrated in Fig. 4. One of these, which was constructed by the Maschinen-

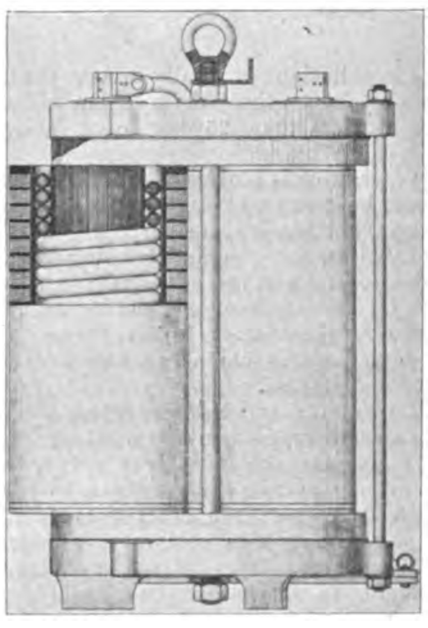


Fig. 4.—High Potential Transformer.

fabrik Oerlikon, reduces the potential of the line to 100 volts with a corresponding increase in the current strength. This transformer feeds a battery of 100 incandescent lamps arranged in the shape of an illuminated sign, and consumes about 100 h. p., that is, half of the power transmitted. The remaining part of the current, a trifle over 100 h. p., is converted by two transformers made by the Allgemeine Elektricitäts-Gesellschaft, and also reduces the tension to 100 volts. These transformers, as will be seen, consist of

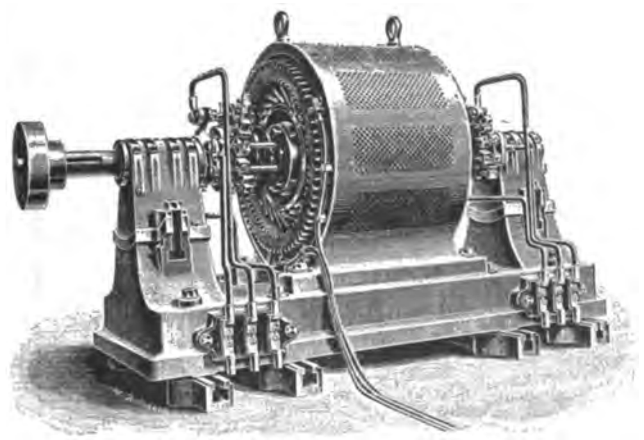
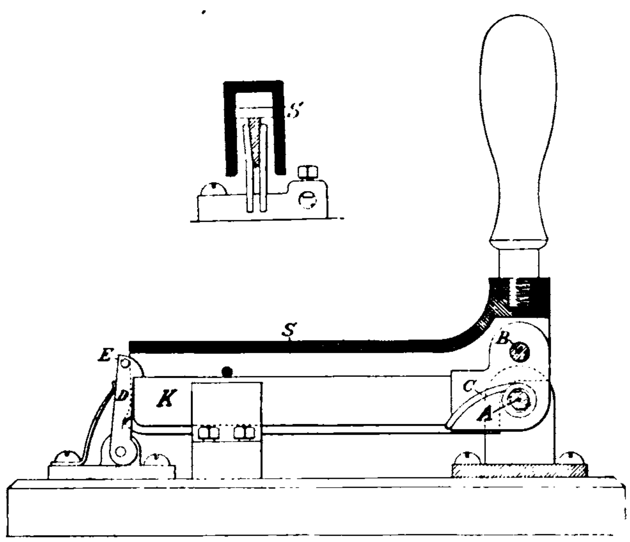


Fig. 5.—Large Rotary Phase Motor.

three cores having the low potential secondary wound next to the iron and surrounded by the high potential primary, which is built up in sections to secure more thorough insulation. The secondary current from these transformers drives the large electric motor of the Allgemeine Elektricitäts-Gesellschaft, which is illustrated in Fig. 5, as well as a number of smaller motors also built on the rotary phase system. The large motor has current led to it through six circuits, and makes 600 revolutions per minute. It is connected directly to a centrifugal pump, built by Brodnitz & Seydel, of Berlin, and raises the water for a large artificial waterfall to a height of 10 metres.

THE KINTNER JACK-KNIFE SWITCH.

A very simple and effective quick-break switch for high-tension currents has recently been designed by Mr. Charles J. Kintner, of this city, and is clearly shown in the accom-



Kintner Jack-Knife Switch.

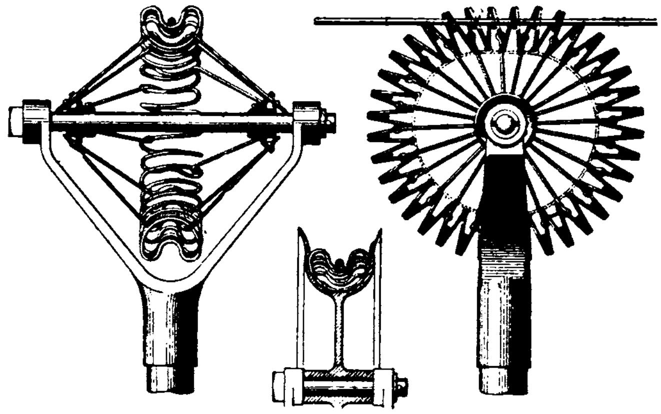
panying engravings, Fig. 1 being a longitudinal, and Fig. 2 a transverse, section.

As will be seen, the jack-knife K is pivoted at A, and completely covered and protected by the shield S, made of insulating material, and turning about the pivot B. A powerful spring, C, is coiled about the pivot A, and tends always to keep the switch open, while the pawl D firmly holds it in position when once closed. A pin, E, passing through the upper end of this pawl, rests normally against the curved end of the insulating shield, shown in dotted outline in Fig. 1.

The operation is as follows: The switch being closed, as shown in Fig. 1, the handle, fastened to the insulating shield, and in noway connected to the switch itself, is drawn aside, or down. The shield, rotating about the pivot B, moves upward, pushing againt the pin E, and throwing the pawl D out of contact with the knife K, which, thus released, is violently thrown open by the action of the spring C. The pawl is held at right angles to the base of the switch by a spring, and re-engages the knife-blade automatically when the switch is again closed.

THE WETMORE MULTIPLE CONTACT TROLLEY WHEEL.

In the operation of overhead electric railways, considerable annoyance has been experienced from the sparking at the trolley wheel, due to insufficient contact with the trolley wire. In order to obviate this difficulty, Mr. Jean A. Wetmore, of this city, has designed a trolley wheel, by the use of which contact is obtained at several points simultaneously.



Figs. 1, 2 and 3.—Wetmore's Multiple Contact Trolley Wheel.

In this device, which is shown in the accompanying illustration, the periphery of the trolley wheel is composed of a helical conductor, the convolutions of which are capable of yielding under the pressure of the wheel upon the wire to such an extent that several of them are always in contact.

In the forms shown in Figs. 1 and 2, yielding arms or spokes are used, increasing still further the elasticity of the wheel. Fig. 3 shows part of a solid wheel, having a recess in which the helical conductor is seated. In this form the multiple contact is afforded by the yielding of the individual convolutions only.

NEW SYSTEM OF ELECTRIC RAILWAYS.

In a new system of electric railways, invented by Herr Heilmann, a steam engine and dynamo are carried in a vehicle which takes the place of the present locomotive. Current is conveyed by conductors, which pass under the cars, to a series of electric motors, which drive some or all of the axles. A triple-expansion engine is to be used, and in order to ensure equal work being done by all the motors, their armature coils are all in series with one another, and current is supplied from one dynamo. The field magnets of the motors and of the generating dynamo are excited by current from a dynamo working at a constant potential. The boiler is capable of developing 600 horse-power, and is of the type in general use on torpedo boats.

SOUND PRODUCED BY AN ELECTRIC CURRENT.

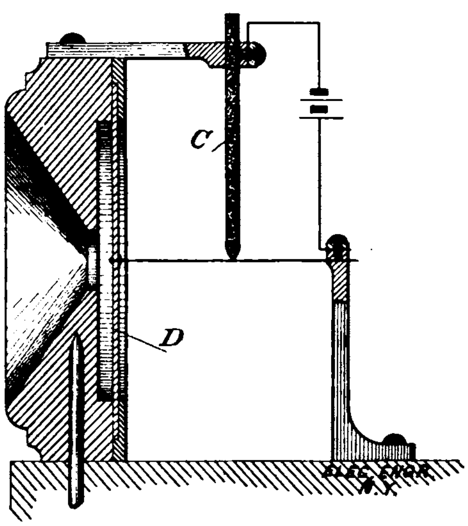
BY

Edward P. Thompson

During some tests in telephony, the writer employed a fine wire, which was placed under tension and in loose contact with a carbon rod C, as shown in the accompanying illustration. A diaphragm, D, of a telephone ear-piece served to hold one end of the wire. When the circuit was open, no sound was heard, but when closed, a faint musical note proceeded from the ear-piece. The cause of the sound was located at the point where the carbon touched the wire, because no sound was heard when the current was passed through the whole length of the wire.

The sound was not produced by disturbances of the air or contiguous objects, because no sound was heard when the circuit was open. When the carbon was replaced by metal, no sound was heard either with an open or closed circuit. When the wire carried a carbon in contact with the stationary carbon, the sound continued as long as the circuit was closed, but with the arrangement of one carbon touching the wire, as shown in the engraving, the sound ceased after a few seconds. The size of wire was No. 34 B. & S. copper, and the current was derived from two small Leclanché cells. When performed in the dark, intermittent minute sparking was visible at the carbon contact. The constant current of the cells was converted into a vibratory current, as evidenced by a telephone receiver introduced into the circuit.

Logical reasoning dictates that heat at the carbon contact is the cause of the vibration. According to this theory, the wire becomes heated at that point because the resistance is very high. Expansions of the wire, carbon and air, and chemical actions occur, producing relative displace-



Sound Produced by Current.

ment which varies the current and therefore the heat. The rapid repetitions of these actions vibrate the wire and sound is consequently heard at the diaphragm.

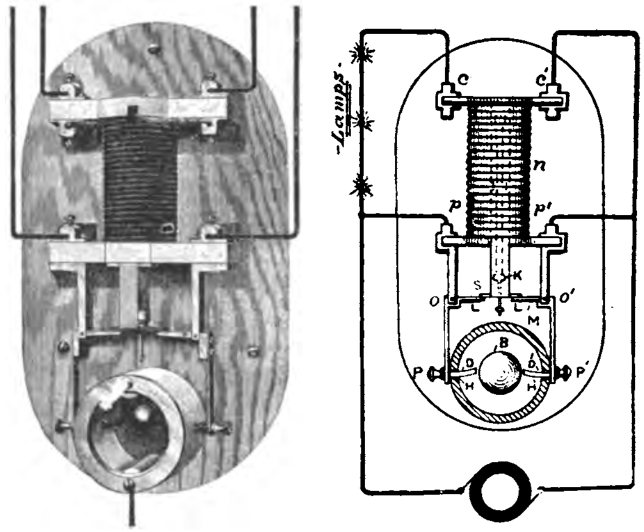
ELEVATED ELECTRIC RAILWAYS FOR BERLIN.

The Berlin correspondent of the *Daily Chronicle* says that Messrs. Siemens & Halske have submitted a proposal to the Minister of the Interior and the Berlin Municipality for the construction of elevated electric railways throughout Berlin and the suburbs. They propose to construct eight different lines, covering some 40 miles, at an estimated cost of 84,000,000 marks.

THE WESTINGHOUSE ARC LIGHTNING ARRESTER.

The first function of a lightning arrester is naturally to find a quick and sure path to the ground for the electric discharge. The second function is that of interrupting the dynamo current in the event of its following the lightning stroke and making a short circuit.

Both of these conditions have been successfully carried out in the new Westinghouse arc lightning arrester shown in the accompanying illustrations. As will be seen, it con-



Figs. 1 and 2.—Westinghouse Arc Lightning Arrester.

sists of a closed box, M, containing a carbon ball, B, connected to the ground. The box is penetrated by two electrodes, D, D', pivoted at O, O', and arranged to swing freely in the openings H, H.' Under normal conditions of running a plant, these electrodes are adjusted by the thumb-screws P P' to rest within one-eighth inch of the carbon ball. In the event of a lightning stroke the discharge passes through the binding posts P P', and traveling by way of the electrodes D D,' jumps the one-eighth-inch air spaces and escapes to the ground. On the dynamo current following, the solenoid n, regularly in series with the lamp line, is short-circuited, and the core K, being no longer held up by the magnetic field of the solenoid, drops upon the levers L L', and by the force of its blow causes the electrodes D D' to be drawn a little away from the carbon ball B. The arcs thus formed at once raise the air in the closed box M to a very high temperature, expanding it and causing a quick blast to escape through the holes H H', blowing out the arc and breaking the circuit. This allows the current to resume its normal path through solenoid n by way of the binding posts C C', draws up the core K, and, the electrodes falling back to their normal position, the arrester is ready for another discharge.

The beauty of this principle so successfully adopted in the incandescent lightning arrester is most clearly demonstrated again in the case of the arc arrester. In the laboratory tests of this instrument, the electrodes are adjusted so as to touch the carbon ball, thus forming a dead short circuit on the dynamo, other connections being made as in the diagram. A short circuit is, therefore, automatically and repeatedly opened and made, this being done without further demonstration than a slight puff as the arcs are blown out.

A LIGHTNING CONDUCTOR IN 1783.

According to *La Lumière Electrique* a curious discovery has recently been made in the shape of a speech by Robespierre, occupying 100 printed pages, in defence of Sieur de Vissery, who was appealing in 1783 against a judgment delivered by the sheriffs of Saint Omer ordering the destruction of a lightning conductor erected by him.

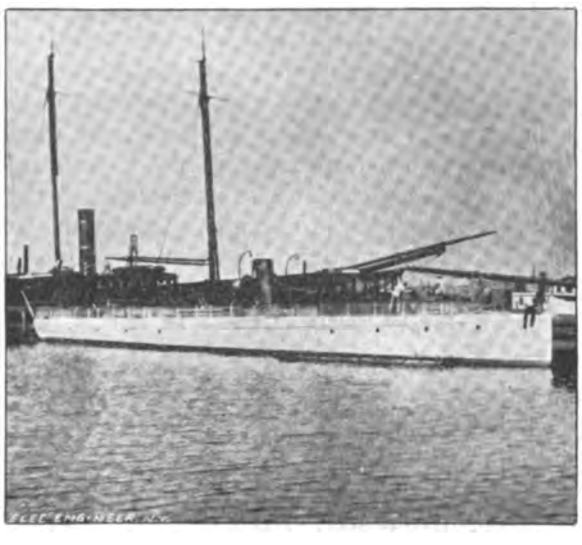
THE "VAMOOSE'S" COMPACT LIGHTING PLANT.

Andrew L. Riker.

Few craft of late years have attracted so much attention as the swift little "Vamoose," built specially for young Mr. Hearst, of San Francisco, who gave carte blanche to designers and constructors in order to secure from them a craft of unrivaled speed. Her recent performances around Rhode Island and in New York waters have been very promising and have aroused the liveliest interest. This week, on Saturday, she will race with the famous "Norwood," which has enjoyed the reputation of being the swiftest steam yacht afloat; and it is said, with regard to the "Vamoose," that she is likely to cover the 92 miles of the course in about 3½ hours.

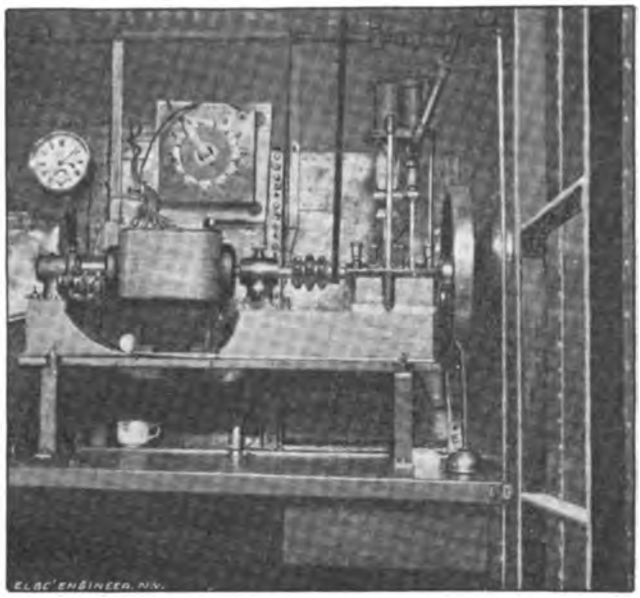
The "Vamoose," herewith illustrated, was built by the celebrated Herreshoffs, of Bristol, R. I., who have turned out a craft that looks fully equal to a steady 25 miles an hour, as called for by her contract. The rakish boat is 110 feet long and 12 feet beam, with a displacement of 31.62 tons. Her deck is flush, with only a pilot house forward, and is enclosed by a light railing of spun yarn—the only bulwark she possesses. Even her pilot house is said to be easily removable, if desired.

The chief consideration about such a boat is lightness, combined with great power in her machinery, and this applies as much to her electric lighting plant as to her propelling gear. Her engines are of the Herreshoff build, being quadruple expansion and of 800 h. p., with Thornycroft boiler tested to carry 250 pounds of steam. Refined and small as this machinery is, it occupies fully one-third of the available space in the boat, and the electric light plant had therefore to be extremely compact as well as light. The "Vamoose" is herself of composite build,



The "Vamoose."

with steel frame and wooden planking. With the object of securing just the plant they needed, the builders and owner called in the services of Mr. A. L. Riker, and the contract for the plant was given to the Riker Electric Motor Co., of Brooklyn, N. Y. The plant designed by Mr. Riker and furnished by the company is the only part of the yacht not furnished from the Herreshoff yard at Bristol, and had to be in every way up to the very critical and exacting ideas there prevailing. As shown in our direct-process engraving, the dynamo and engine are coupled direct and are mounted on the same base. The dimensions are: Length, 38 inches; breadth, 10 inches; height, 15 inches. The total weight is 450 pounds. The dynamo is a two kilo-watt bi-polar machine of the perfected Riker type, with self-oiling bearings and self-adjusting carbon brushes. It is compound wound, and is thoroughly water-



The "Vamoose's" Dynamo Plant.

proof. It is run by a 3 h. p. Herreshoff engine at 800 revolutions per minute, and is capable of supplying twenty-five 16 c. p. lamps and a search-light of 2,000 c. p. Such a plant evidently meets the prime consideration of lightness combined with high efficiency, and it also answers the requirement of compactness. The plant is placed on a small bracket made of iron, and thus fastened to the side-wall of the engine-room, where it runs so noiselessly that its presence is hardly noticed unless one is looking for it. The plant has given great satisfaction and is deservedly regarded as one of the most ingenious parts of this wonderful "lightning" craft.

THE PRACTICAL EFFICIENCY OF TELEGRAPHIC APPARATUS.[1]

The following table relating to the "efficiency" of the various telegraph instruments employed by the French Post Office is of interest. A message is reckoned at 20 words, and each word at 7.5 letters:

Apparatus.	Average number of messages per hour.	Number of operators.	Average number of messages per hour per operator.
Morse	25	2	12.5
" (duplex)	50	4	12.5
Sounder	40	2	20
" (duplex)	80	4	20
" (quadruplex)	160	8	20
Wheatstone	100	10	10
" (duplex)	200	18	11
Delany (quadruplex)	160	8	20
Baudot (quadruplex)	160	10	16
Hughes	50	4	12.5

1. *La Lumière Electrique.*

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XII. NEW YORK, SEPTEMBER 30, 1891. No. 178.

Nothing is so good as an experiment which, while it sets an error right, gives as a reward for our humility in being reproved, an absolute advancement in knowledge.—Faraday.

ELECTRIC RAILROADS FOR THE FARMER.

AFTER seeing in the New York daily papers for months together nothing but abuse and falsehoods on the subject of electric railroads, it is refreshing to come across some statements that show the writer to have looked the facts fairly and squarely in the face. Not that it matters much what is said ignorantly against the electric road, but this improved method of travel will certainly the sooner benefit the public and perform its mission if the daily press is with it. The cheering utterances we refer to were published last week by the *Evening Post*, in the shape of correspondence from Cleveland, and their nature may be gathered from a single sentence: "Hamlets that have been left to one side by the steam railroads because of heavy grades or for more liberal patronage elsewhere, can find in the electric road something that solves the question of transportation for them better than anything else."

The article also shows that the superiority of the electric road holds good for city suburbs also, and it goes on to tell of what is being accomplished in and around Cleveland. Of one road it is stated that property has advanced several hundred per cent. since it was built, while the great boon to be conferred by others is clearly pointed out. But the main interest of the article lies in its allusion to the projects for rural roads. One of these, in which Mr. Charles F. Brush, the great inventor, has a hand, is to run twenty miles, touching five towns and eight post offices that have been left high and dry by the old steam railroads. This road will be equipped with freight cars of a carrying capacity of five tons or more for the special handling of farm products. Other roads of similar character are mentioned, and the fact comes out incidentally that they will but serve as links between electric roads already in successful operation. In reality the region around Cleveland, like that around Boston or Minneapolis, is becoming a vast network of electric roads, making money for the owners and doing good to the public under conditions that have rendered travel by horse and steam hopeless.

This use of electric roads for farm work is destined to be enormous. At the present time the state of the vast majority of our rural highways is such as to render transportation a frightful tax upon production. But nothing is easier than to track and wire these roads, furnish them with motor trucks upon which the farm wagons can be run fully loaded, and then turn on the current at stated intervals from the power house in the nearest town or at the nearest water power. These electric roads will continue running through winter and spring months when the ordinary dirt roads are utterly impassable and when the multitudes of draught horses kept by the farmers are simply eating their heads off in idleness. In 1880 there were 2,000,000 such horses on American farms. The bare possibility of getting promptly to market will stimulate the farmer to cultivate crops that now he dare not dream of. Moreover, the speed made will effect a most tremendous economy in the farmer's time.

These views were outlined in THE ELECTRICAL ENGINEER a long time ago and more than once, and every day sees some action on the part of projectors and capitalists that justifies them to the full. To quote again from the *Evening Post:* "Whatever verdict the future may pronounce upon electric traction as a means of rapid transit in great cities, no intelligent observer can doubt that one very important field of usefulness is open to the electric motor, for which it is unquestionably better adapted than any other means of transportation, and in which it easily surpasses all others—the development of the country surrounding a large city, and the furnishing of ready, cheap and usually reliable communication between country towns."

THE FREEHOLD OF THE AIR.

MODEL cities have always been a favorite topic of the philosopher and social reformer, but it is not often that a plan is drawn out intended to have direct and immediate application to the pressing needs of the hour in such a great centre of trade and population as New York. Such a plan is found, however, in the daring and suggestive paper read last week before the Electric Club by Mr. Allen R. Foote. He sees clearly, and says plainly, that the want is not only "rapid transit," but "cheap traffic," and that these demands cannot be met by simply carrying people further away from their work. Every mile that intervenes between the laborer and his labor is an added fine on industry. Mr. Foote therefore proposes to give the workingman the benefit of the freehold of the air, and to place the home and the factory under a common roof in huge "squares" along the fronts of the North and East

Rivers. These lofty buildings in closest access to all the facilities for handling raw material, yet lifting their "homes" into the pure, serene sky, will give New York more domestic comfort and cheaper manufacturing and larger commerce than she ever had before.

Who shall say that this is visionary? The trial of such a plan could be very simply made with one block on either river, and it would at least remove some of the horrible eyesores which, with blunt American frankness, we have put at our water's edge to greet the visitor with on his arrival. Already London and Brooklyn have such buildings and their success is not small. With electric light and power, their use and value can be increased many times over.

Let such plans be tried, and let us have also underground roads piercing in every direction; and then New York will be a city fit to live in and to work in. At the present minute it is one of the most conspicuous failures in the matter of city building and city governing in the world. We New Yorkers are proud of it, not so much because of what it is as of what we propose to make of it; and we are desirous that every thoughtful man of large heart and clear vision shall tell us how to shape the work.

THE FRANKFORT ELECTRICAL CONGRESS.

The recurrence at intervals of a few years of electrical congresses in various countries cannot but be looked upon as a sign that the electrical arts and sciences have attained an importance equal to that of any of the recognized professions of the day, a condition which, we have reason to believe, was until recently denied by many in the older professions. At all the congresses thus far held questions of international importance were brought forward, and although in this respect, probably, the Frankfort Congress shows the least results, it nevertheless served to bring into closer intimacy the workers of many nations, and thus advanced us one step nearer to the realization of uniform practice. From the reports of Prof. Heinrich, which appear in another column, it would seem that the German congress was not fully prepared to accept the "henry" as the designation of the unit of inductance, final action having been postponed until the meeting of the congress at Chicago in 1893. The reason for this delay is hardly apparent in view of the fact that the term has gone into use in all English-speaking countries, and that the German technical press has employed it exclusively since its introduction and adoption by the American Institute of Electrical Engineers. It is, however, only a question of time when it will receive a formal, general recognition, and thus become one of the established names.

POLE-PIECES AND THE AIR GAP.

The recognition of the importance of the air gap in dynamo-electric machinery served to call into existence a considerable amount of literature on the subject of the design of such machines, and probably most of the work done in the last five years is based largely upon the relation of the air gap to the rest of the magnetic circuit. One of the most important effects which the new theory of the magnetic circuit has had on modern construction is the return by many to the tooth form of armature. But that there are still numerous questions to be solved as to the best proportions to be adopted will be evident from a perusal of the paper read by Prof. Ryan before the American Institute of Electrical Engineers. It is gratifying to know that Prof. Ryan's results agree with those of Messrs. Swinburne and Esson on this subject, whose work we have reason to know has been followed by not a few in this country. As regards the pole-pieces, Prof. Ryan has, we believe, pointed out again the true cause of frequently unexplained irregular action in machines, which, as he shows, can be traced directly to the saturated corners of pole-pieces. The recognition of this phenomenon is especially valuable in the design of constant-current machines, and the experiments which Prof. Ryan cites show in a marked manner the importance of maintaining a uniform strength of field over the entire surface of the pole-piece. It must be borne in mind, however, that the restrictions here made, while applying to the pole-pieces, need not necessarily apply to the rest of the magnetic circuit, since in in some types of machines a saturated field-magnet core may be desirable in order to obtain certain effects.

WESTERN UNION AND THE POOL ROOMS.

The papers of Saturday last contained a very circumstantial account of the manner in which the latest scheme of the Western Union to defeat the managers of the local racecourses and give news to the pool sellers had been detected. The plan appears to have consisted in sending dispatches from an open barouche, by flashes from a little incandescent lamp, seen through the ventilating space in the coachman's hat, and read at a short distance by an operator on the tower of the hotel just outside the track, which, in this instance was that of the Brooklyn Jockey Club. As the barouche contained apparently, each day, an ordinary family party, it escaped notice for some time, but the lively movements of the occupants of the coach in getting the news and dispatching it at last attracted attention. The detectives then made it their business to investigate the carriage and they found it to contain a very complete set of telegraphic and electrical apparatus. The persons concerned in this truly ingenious scheme were arrested, but were afterwards bailed out by a Western Union officer and a pool-room and faro bank magnate named DeLacy. We can only say that this is pretty small business for the Western Union Company to be engaged in.

Aluminum.

Electrical engineers above all others have taken a lively interest in the production of aluminum, not only on account of the electrical methods involved in its modern manufacture, but owing to the fact that it will soon play an important part as one of his materials of construction, not merely, as heretofore, for the moving parts of measuring instruments, but also in heavy engineering, such as electric railway and motor work generally. Naturally some difficulties have been met with in the applications of this new metal, and the trouble as pointed out in an other column by Mr. W. F. Barnard is lack of purity. Still it seems to us that there are many applications for aluminum where purity is not a prime essential, and the reputation of the metal ought not to suffer because knowledge is still needed of the quality that will yield the desired results for certain specific purposes.

THE FRANKFORT INTERNATIONAL ELECTRICAL CONGRESS.

BY

Richard O. Heinrich.

THE International Electrical Congress held in connection with the exhibition at Frankfort was formally opened on September 8, by the Honorary President, SECRETARY OF STATE V. STEPHAN, who, in an excellent address, reviewed the objects of the Congress and welcomed the delegates. WERNER V. SIEMENS then took the chair as President of the Congress, and MESSRS. PREECE, HOSPITALIER, FERRARIS, WALTENHOFEN and W. KOHLRAUSCH were elected vice-presidents.

The first paper which came up before the meeting was that by PROFESSOR W. KOHLRAUSCH, of Hanover, on "The Most Suitable Course of Instruction for Electrical Engineers." In order to elicit the opinions of those present on this subject, the author spread before them the course he had laid out for the High School. Besides a large amount of mathematics and drawing, he laid special stress upon the value of physics and more particularly the study of electricity and magnetism. To this he would add special electro-technical knowledge, the study of the machines in most general use, and methods of construction, etc. He also pointed out the great value of chemistry in view of the importance which electro-chemistry will have in the near future. In the discussion which followed, DR. SLABY maintained that a distinction ought clearly to be drawn, and the selection early made, as between the studies for the physicist and the engineer. For those intending to become engineers, he suggested preliminary work in a machine shop, then a course of study at a high school with special reference to electrical engineering. He considered the *How*, not the *What*, of instruction, the principal point to be kept in sight. WERNER V. SIEMENS contended that there was no such thing as electrical edgineering as an independent profession, and that it was merely a science to aid other technical branches, and that a person could only become an electrical engineer by actual practice. HERR HARTMANN, of Frankfort, strongly advocated preliminary workshop practice for a year, which he considered quite sufficient for entrance into the High School. As long as no State factories existed for this purpose, he recommended the student to enter small shops in preference to the large ones. DIRECTOR RATHENAU, of Berlin, also considered the workshop indispensable and inclined to a course of two years.

PROF. SILVANUS P. THOMPSON, of London, who was greeted with great applause, presented a paper in German on "The New Domain of Alternating Currents. He traced the history of alternating currents from Faraday, and their application first to telegraphy, and their more recent applications to electrical distribution. He considered it almost inexplicable why the theory of Deprez and Carpentier, enunciated in 1881, had so long remained without application. He also alluded to the new application of alternating currents for the transmission of power and the experiments of Hertz on the propagation of electrical waves in space and to the more recent work of Mr. Tesla in alternating currents of high frequency. Still other questions remain to be solved by means of the alternating current, such as the transmission of pictures, ocean telephony, etc. He considered that the solution lay in the development of the wave theory of electricity.

In Section 3, Telegraphy, Telephony and Signals, DR. STRECKER, of Berlin, was elected president, and the first paper was presented by HERR BERG on "The Application of Electricity in Navigation." The author criticised the English rules by which it was intended to prevent the influence of the heavy electric currents on the compass, and then proceeded to describe the marine signal system, invented by the Austrian navy officer, Selluro. In the discussion which followed, HERR BECHTHOLD, of Vienna, remarked that in the Selluro system the signals were independent of the ship's dynamo, being operated by hand dynamos.

MR. WILLIAM H. PREECE then presented a paper on "The Progress of Telegraphy and Telephony in England." The author remarked that in 1852 Cooke and Wheatstone's double-needle instrument was in general use in England, and that one wire transmitted on an average 10 words per minute. At the present time over 600 can be sent over a single wire. MR. PREECE considered that there were four essentials requisite for the scientific success of telegraphy: 1. Well-built lines that must be free from interruptions. 2. Complete apparatus, which utilizes the current to the highest degree. 3. A thoroughly trained staff of employees who are not afraid to work and are accustomed to accuracy. 4. Rapidity in the delivery of the telegram. Mr. Preece then described the construction of the lines and apparatus employed in England, and also gave some account of the pneumatic tube system employed in some of the large cities in England. On the subject of telephony, Mr. Preece remarked that little progress could be noted here, and, in fact, that they were ashamed of the state of telephony in England at the present time. They were still in such a condition as led them to believe that the telephone was best taken care of in the hands of private parties. The Government had proved the practicability of long-distance telephony, and Mr. Preece referred more particularly to the line between Paris and London and the results obtained with it. Mr. Preece also referred to the great speed made possible in automatic telegraphy in England by the introduction of relay stations, the excellent construction of the apparatus, the complete removal of all retarding influence, which latter was the direct consequence of the introduction of shunted condensers, the application of which Mr. Preece considered as important an advance as was the compound engine in steam engineering.

In the discussion which followed, HERR GRAWINKEL, of Berlin, privy counsellor for Postal Telegraphs, remarked that much of the success of telegraphy in Germany was also due to the application of condensers. They had been able to talk over cables as long as the distance from Paris to London and with the ordinary arrangements. HERR GRAWINKEL, however, raised some objections to the well-known formula introduced by Mr. Preece for the limiting talking distance of telephone lines. MR. A. R. BENNETT, of London, remarked that telephony in London was cheap and nasty, and seemed to be run for the sole purpose of making a profit, but that marked changes would soon become apparent.

In the meeting of Section 2, devoted to Heavy Currents, a report was presented by HERR GEIST, of Cologne, on "The Dynamo as Arranged for the Measurement of Mechanical Power," in which the author described the application of the well-known cradle dynamometer principle. This was followed by DR. FOERDERREUER, of Nuremburg, who read a short paper on the multiphase alternating motor, and alluded to the simple manner by means of which such a machine can be placed in synchronism by noting the exact period with the aid of a voltmeter. HERR DÉRI, of Vienna, stated that several years ago he had applied for a patent in connection with Herr Zipernowsky for the application of the ordinary dynamo to the generation of multiphase alternating currents.

In Section 1, Theory and Methods of Measurement, HERR DR. KOEPSEL, physicist to the firm of Siemens & Halske, read a paper on "The Present Condition of Electrical Mensuration." The author divided the various measuring apparatus into two groups, namely, those measuring directly, and indirectly. Among the latter he classed the voltameter, the calorimeter and the shunt resistances to galvanometers. Among the former he counted the electro-dynamometer and other instruments. The speaker referred to the difficulties encountered in all instruments involving permanent magnets in their construction on account of the inconstancy of their magnetic strength. He considered the application of the static instrument as of increasing importance with the general introduction of high-tension currents. The speaker also referred to the lack of a reliable apparatus for the measurement of self-induction. After a brief note on "Standard Cells," by DR. LINDECK, a discussion arose on the paper of Dr. Koepsel. PROF. HEINRICH, of New York, declared that the Weston Electrical Instrument Company had constructed instruments direct reading with permanent magnets, the constancy of which was practically perfect. PROF. VOLLER, of Hamburg, added that the testing committee of the exhibition had made experiments with the Weston instruments and subjected them to severe shocks. Some of the instruments had shown no variation after this treatment, while others had changed considerably. It was quite possible, as Prof. Heinrich maintains, that those which changed were old instruments; nevertheless DR. KOEPSEL denied that it was possible to construct absolutely permanent magnets which could remain constant not only in the laboratory, but also in the vicinity of machines.

The American Institute of Electrical Engineers was represented by Profs. Nichols and Heinrich, and Messrs. Hering and Gutmann. They presented a resolution asking for the adoption of the "Henry" for the unit of induction. The matter was referred to a committee and definite action was postponed until the World's Fair at Chicago, in 1893, since it could not be adopted unanimously, Siemens and others opposing it.

The Institute Committee also suggested that either now or between this and the next Congress the two following subjects should be considered and discussed in order that they may be definitely acted upon:

First, the determination and naming of a practical unit of the intensity of a magnetic field, for which there exists a pressing need. They proposed to call this unit the "Gauss" and to fix its value at 1,000 lines of force per square centimetre.

Second, the determination of a standard value for the conductivity of copper for commercial purposes in order to facilitate the designation in per cent. of different qualities of copper. They also invited the members of the present Congress in the name of Institute to take part in the International Congress, which is to be held at Chicago in 1893 under the auspices of the American Institute of Electrical Engineers.

The attendance of the Congress is very large, the total number of participants aggregating 661, of whom 220 are foreigners, there being 7 present from America.

ON THE RELATION OF THE AIR GAP AND THE SHAPE OF THE POLES TO THE PERFORMANCE OF DYNAMO-ELECTRIC MACHINERY.[1]

BY HARRIS J. RYAN.

THE object of this paper is not to deal with the subject in a new light, but to add to its literature a limited amount of data, the deductions from which go to establish the correctness of the ideas, and the utility of the suggestions put forth in the papers read by Messrs. Swinburne and Esson, at the meetings of the London Institution of Electrical Engineers on Feb. 13 and 20, 1890. Up to the time of the publication of these papers, the air gap was usually treated by contributors to electrical literature as an evil in a dynamo having a necessary existence, and the smaller that it could conveniently be made, the better. The shape of the poles had often been spoken of as having a somewhat decided effect on the performance of the dynamo, while but little had been said regarding the cause of such an effect.

There exists some difference of opinion as to what should be known as the number of ampere turns on an armature. For our present purpose we will assume that the

$$\text{Armature ampere turns} = \frac{\left\{\begin{array}{l}\text{The No. of conductors on}\\ \text{the surface of the arma-}\\ \text{ture.}\end{array}\right\} \times \left\{\begin{array}{l}\text{Strength of current}\\ \text{on the armature}\\ \text{conductors.}\end{array}\right\}}{\text{Number of poles.}}$$

Referring to Fig. 1, it is evident that when we consider the magnetic forces acting in a working dynamo by the route O, I, J, O, that the entire number of ampere turns on the armature are directly opposed in action to the ampere turns on the field. By the route O, M, N, O, all the ampere turns on the armature except those that lie between the double angle of lead G, E, are acting with the field ampere turns, while those between G, E, are opposed to the same. Therefore, by this route the total number of amperes turns actually aiding the field ampere turns is the total number of armature ampere turns, minus twice the number of ampere turns that lie between the double angle of lead. By the route O, K, L, O, the number of ampere turns acting is the number of ampere turns on the field, minus the number of ampere turns

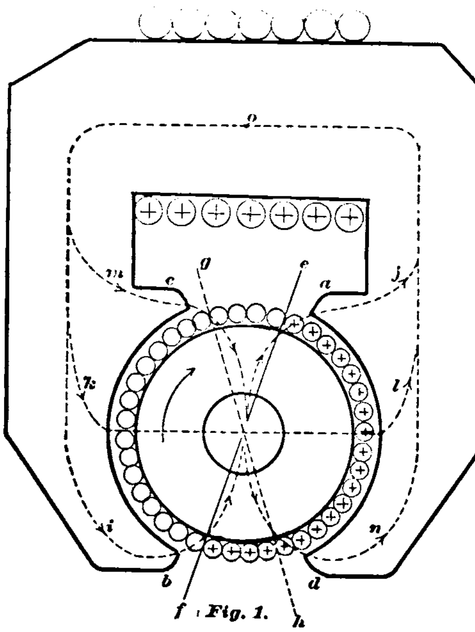


Fig. 1.

that lie between the double angle of lead. We can then estimate with ample practical accuracy the magnetic density in the air gap at all points, for any given total amount of magnetization through the armature. The ampere turns that lie between the double angle of lead are opposed to the action of the field ampere turns at all points. It is evident that the portion of the armature ampere turns not included between the double angle of lead will increase the magnetization through the air gap by the route O, M, N, O, just as much as they diminish it along the route O, I, J, O, as long as magnetic saturation does not take place in the strengthened pole corners C, D. If the pole corners are thin, as in the types shown in Figs. 2, 3, and 5, saturation is apt to occur. It is then that the magnetic resistance increases by the route O, M, N, O, and the magnetic density by this route is no longer increased by the same amount that it is diminished along the route O, I, J, O. On the other hand, when the pole corners are fashioned as seen in Figs. 4 and 6, so that saturation in the strengthened pole corners cannot occur in practice, the current in the armature can produce no modification of the total amount of magnetization through it, other than that which is produced by the action of the ampere turns that lie between the double angle of lead. This action can always be compensated for by putting an equivalent number of series ampere turns on the field acting with the field ampere turns. The double angle of lead can be determined with sufficient accuracy, for with pole corners slightly extended at the centre, see Fig. 11, the diameter of commutation at all loads is very near the weakened

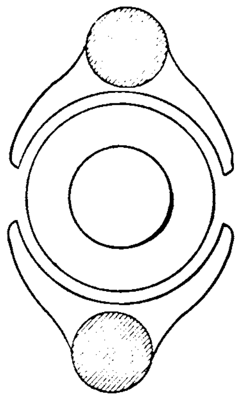


Fig. 2.

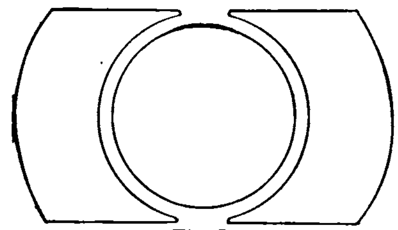


Fig. 3.

pole corners. The pole corners are slightly extended at the centre, so that the coils always enter the field of the weakened pole corners gradually. The E. M. F. developed in the coils as they pass under the poles can never be far different from that actually needed to reverse the current in the coil when passing under the brush. In this way the point of commutation in a dynamo can be kept the same when carbon brushes are used without undue sparking, as long as the armature does not reverse the magnetization under the weakened pole corners.

From the discussion of the magnetic relations of an armature to its field in a dynamo in connection with Fig. 1, it is seen that the magnetization in the air gap under the weakened pole corners becomes zero, when the armature ampere turns are equal to the ampere turns on the field, whose magnetizing force is impressed between its pole faces through the armature. This impressed magnetizing force is that due to the difference between the total number of ampere turns on the field and the number of ampere turns required to set up the magnetization through the field cores, from pole face to pole face. In order to commutate the current without spark at the commutator, the magnetization in the air gap under the weakened pole corners dare never be allowed to become zero. It follows then that the field ampere turns impressing a magnetizing force between the pole faces must always be somewhat in excess of the maximum number of ampere turns on the armature. The amount of this excess need only be sufficient to insure a positive field at A and B, Fig. 1, strong enough to reverse the current in the coils as they are commutated. When a certain amount of magnetization is to be set up through an armature with the application of the magnetizing force of a given number of ampere turns impressed between the pole faces, we must provide the requisite amount of magnetic resistance between these pole faces. The value of this resistance will have to be such that the impressed field magnetizing force will establish the desired amount of magnetization. This resistance in most cases is best provided for in a proper length of air gap. In general it is found best to avoid heating in the armature core as far as consistent, by the use of comparatively low magnetic densities for wrought-iron. The magnetic resistance of the armature core under these circumstances is very small and may be neglected.

The magnetic resistance between the pole faces is occasionally provided for largely, either through a saturated core of a ring armature, saturated lugs on armatures where the wires are placed in grooves, or both. This in addition to what air gap may be necessary from a mechanical point of view go to make up the total amount of magnetic resistance that is provided between the pole faces. Machines of this order have been developed largely through the old and rather expensive method of experimentation. This method has given us some types in which ordinary results are arrived at, through rather extraordinary means. Take the case of a machine with a ring armature, wires wound in grooves, a very small air gap, and poles shaped somewhat as shown in Fig. 2. Such a machine operated as a dynamo may require only a quarter of the number of ampere turns that it will have on the armature at full load, for field excitation in order to produce a

1. A paper read before the American Institute of Electrical Engineers, New York, September 22d, 1891.

certain E. M. F. at a given speed. Yet this machine produces a fairly constant potential at the brushes under all variation of load. and without undue sparking at the commutator in the following manner: For the production of a constant E. M. F. at constant speed, the total magnetization through the armature must remain constant. At no load one-fourth of the ampere turns needed on the field at full load are provided by a shunt winding. This shunt winding is sufficient to set up the total amount of magnetization for the production of the normal E. M. F. of the machine when there is no current in the armature. Now, in order to take the normal current from the armature without reversing the magnetization under the weakened pole corners, three times as many series ampere turns as there are shunt ampere turns must be added to the field. The addition of these series ampere turns must not increase the total amount of magnetization through the armature, which is accomplished by the thin pole corners. The strong pole corners become saturated when the armature is furnishing even a small amount of the normal current for which it is designed. For most values of the current, then, the armature ampere turns tend to diminish the magnetization under the weakened pole corners, but cannot increase it correspondingly under the saturated pole corners. The action of the series ampere turns on the field prevents the reduction of the magnetization under the weakened pole corners to zero, while the saturated portion of the pole pieces prevents the increase of the total magnetization through the armature, and thus a constant potential is maintained.

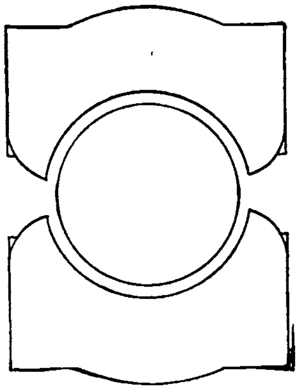


Fig. 4.

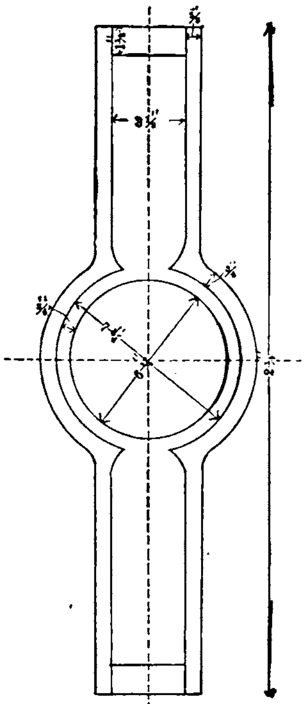


Fig. 5.

The "armature characteristic" IV., plotted in Fig. 7, was taken from the machine of the above sort, built with cast-iron fields. The cross-section of the field cores proved on trial to be too small, and became strongly saturated at full load—while they were quite a little under the point of saturation at no load. This curious result for a constant potential generator was due to the increased magnetic leakage, produced as the series ampere turns on the field came up with the load. Saturation took place as the curve indicates, when the armature furnished a current of about 140 amperes, and no possible compounding could ever make this generator produce even approximately a constant potential, with variation of load. Steel cores of the same dimensions were substituted for the cast iron cores. Saturation did not occur in them due to magnetic leakage. The pole corners were very thin, as in Fig. 2, and the "armature characteristic" III. was obtained. The machine was then furnished with a shunt winding that produced a slightly smaller number of initial ampere turns than curve III. indicates as required to produce 125 volts, and with series turns at such a number that the total number of ampere turns on the field for any current developed by the armature is shown by the broken line drawn through curve III. It was under these conditions that the machine performed in the manner described above, and did not vary more than 5 per cent. from the normal E. M. F. on either side. or a total variation of 10 per cent. It was then almost entirely rebuilt. The armature was provided with a core that was considerably larger in cross-section, and the maximum magnetic density used in it was 11,000 lines per sq. cm. as against 20,000 used before. The lugs on the core were dispensed with, and the wires wound on the surface of the core. The poles were made of cast-iron, and fashioned to accord more

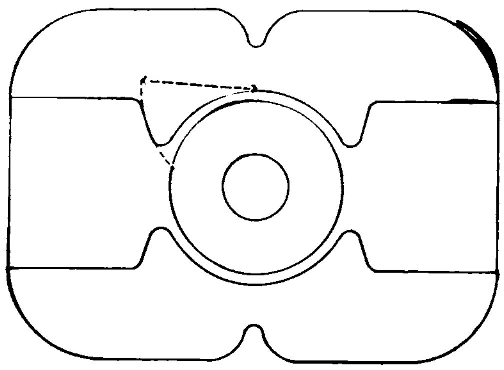


Fig. 6.

nearly with those in Fig. 3. The air gap required ten thousand ampere turns to set up the magnetization through it at no load, while the armature ampere turns were 8,000 at normal output, so that series ampere turns had only to be added to counteract the action of the ampere turns on the armature that lie between the double angle of lead, to increase slightly the E. M. F. by the amount equal to the fall of potential through the armature caused by its resistance, and to compensate for the slight effect of the pole corners that still became saturated to a limited extent for the higher outputs. It should be remembered that the magnetic leakage that takes place between the adjacent north and south pole corners, one of which is strongly and the other weakly magnetized, plays an important part in saturating thin pole corners. It is evident that unless the "armature characteristic" is a straight line as in curve I., Fig. 7, that the machine can not be made to regulate for constant potential with a high degree of refinement. The poles were again changed and shaped as in Fig. 4, when an "armature characteristic" given in curve I. was obtained, and the proper number of shunt and series ampere turns for a refined degree of regulation were readily decided upon. These experiments confirm what has been said above, and show how useless have been the attempts to diminish the air gap beyond certain limits.

It was shown on the outstart how we can calculate the actual magnetic densities in the air gap for any total magnetization through the armature, for any armature current. The results of the following experiments confirm the correctness of these methods. The curves in Fig. 8 give the values of the magnetic density at all points of the air gap of a generator producing

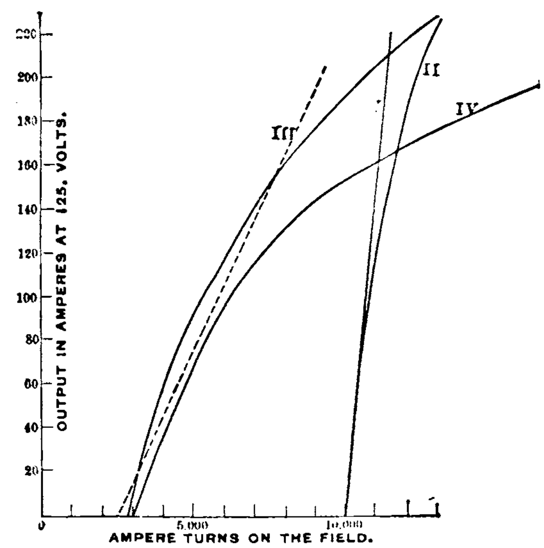


Fig. 7.

125 volts at the brushes and 80 amperes. The following are its dimensions and data:

Diameter of armature core..................	6.25 in.
Length of armature core	12. in.
Diameter of bore of poles..................	7.19 in.

Double depth of air gap	.94 in.
Armature sections	50.
Turns per section	2.
Resistance of armature	06 ohm.
Poles shaped as in Fig. 3.	
Shunt turns on field	6400.
Field current, no load, 125 volts	1.48
Field current, full load, 125 volts	2.10
Speed	1600.
Carbon brushes used without lead.	

The "armature characteristic" curved considerably, indicating that the pole corners become saturated. It is evident too that

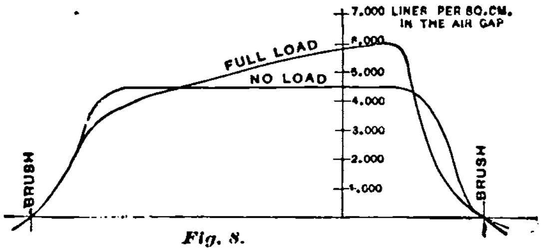


Fig. 8.

the normal magnetization in the pole corners in addition to the magnetic leakage which is greater there than anywhere else, produced saturation in all pole corners, even with no current in the armature. For at full load there were 4,000 ampere turns on the armature, while 4,000 series ampere turns had to be added to the field that produced 125 volts at no load to keep the E. M. F. the same. Therefore at full load we have the same number of ampere turns acting through the weakened pole corners as at no load, and the total amount of magnetization has only been increased 5 per cent., to compensate for the resistance of the armature couductors. The conditions, however, are not the same, for there are just 4,000 more ampere turns to cause magnetic leakage at the pole corners, so that on the whole the magnetization in them is increased. This increase of magnetic density in them greatly increases their magnetic resistance, for they are saturated to begin with. It is on this account that we find the magnetization under the weakened pole corners diminished, when apparently the forces acting have not been changed. The magnetization under the strengthened pole corners through the air gap is increased more than it is diminished by the effect of the added magnetic leakage, through the 8,000 additional ampere turns that act to produce magnetization by this route through the armature.

(*To be concluded.*)

ELECTRICAL DISTRIBUTION AT THE WORLD'S FAIR.

STEADY progress on the electrical work of the World's Columbian Exposition is being made by the Construction Department and an excellent method of distribution of the conductors devised by the able electrical engineer of the department, Mr. Frederick Sargent, has been adopted.

The general plan of distribution embraces the utilization of the elevated railway structure which will run around the grounds, and the building of a tunnel or subway which will contain such wires and cables as are necessary to supply those buildings which could not be reached from the elevated structure.

It has now been decided to place the electrical generators in the Machinery Building and not in the Annex, as before proposed. The generating plant will be arranged along the south wall of Machinery Building, a space being reserved 850 feet long by 200 feet wide for that purpose; the engines being located near the wall and the dynamos towards the centre of the building. Behind the Machinery Building is a covered alley 20 feet wide; then comes the Boiler House, which will extend the entire length of the Machinery Building, and have a depth of 60 feet, the boilers being set towards the north wall and fuel being delivered at the south end of the house direct from the cars brought clear to the doors on a track running in the rear.

The conductors after leaving the dynamos will be arranged in a suitable fireproof rack located under the main floor about 150 feet from the south wall and running lengthwise of the building. From this rack five distinct groups of feeding wires will start as follows:

The first group will supply all the territory contained in the space bounded by 59th street on the north, centre of basin on the south, Lake Michigan on the east, and the lagoon on the west; also the electric fountain, located at the west extremity of basin, and comprising the following: Fisheries Building, Government Building, Naval Exhibit, Manufactures and Liberal Arts Building, Electric Fountain and all the grounds within the territory. The main conduit for this group will be provided in the following manner: Starting from the rack already referred to in Machinery Building, a tunnel or subway will be constructed of sufficient capacity to accommodate 1 0 insulated cables or wires up to 600,000 circular mils area. The tunnel, which is shown in the accompanying engravings, Figs. 1, and 2, will run north from the rack under the floor of Machinery Hall to Electricity Building, with a tap for the electric fountain, the wires for which will be laid on the drawing-in system east from Electricity Building to the bridge, from the bridge to the Manufactures Building. From this point to the north end of the building, a fireproof conduit will be provided, which will gradually diminish in width as the wires are distributed. From the Manufactures Building to the Government Building and thence to the Fisheries Building the tunnel will be about three feet wide, with wires on one side only. The system will terminate at the Fisheries Building.

The tunnel itself, or any of the buildings through which it passes, may be tapped by the drawing-in system, buried in the ground wherever necessary to supply light or power to the grounds or any other buildings that may be erected in this territory. It will be constructed absolutely fireproof throughout. The cross-arms will be made of iron provided with holes at suitable points to receive pins, upon which insulators of various form will be placed; in the case of special insulators special forms of cross-arms will be provided where required.

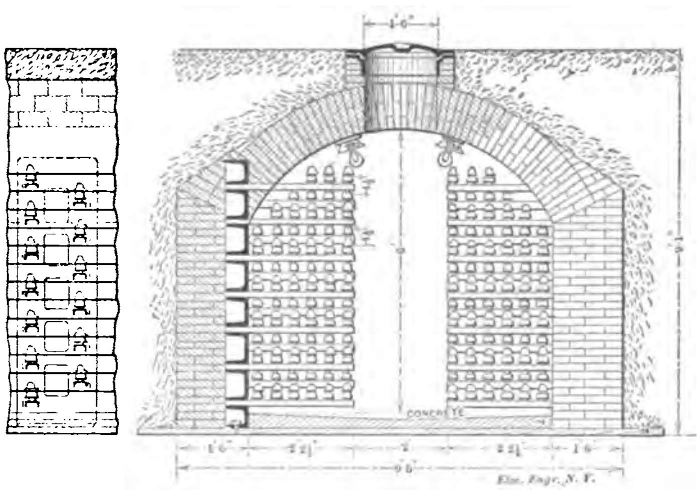
Group No. 2 will be provided for in a tunnel of the same capacity as that for the first group, and will run direct from Machinery Mall to Electricity Building, with branch for the Mines Building and tap for the Administration Building. It will also provide for all grounds adjacent to these buildings, and probably include the wooded island.

Group No. 3 will run direct from Machinery Hall to the Elevated Road, and supply all territory north of the Basin and Administration Building not reached by groups Nos. 1 and 2, including Transportation Building Transportation Annex, Service Building, Horticultural Building, Women's Building, State and Foreign Buildings, Art Gallery, Midway Plaisance and all grounds and smaller buildings in the territory mentioned. The drawing-in systems or buried conductors are to be used wherever elevated structure is not available.

Group No. 4 will provide for Machinery Hall, Machinery Annex, Boiler-House, western portion of Stock Exhibit, and western portion of grounds; the wires to be distributed under basement of buildings and on elevated railway, and thence to grounds and Stock Exhibit by drawing-in or buried systems.

Group No. 5 will provide for: Agricultural Building, Agricultural Annex, Saw Mill, Forestry Building, Dairy Building, eastern portion of Stock Exhibit, Pier and Casino; the wires to be distributed on elevated structure, basement of Agricultural Building, and on the piles under the roadway over the pier so far as practicable, and then by drawing-in or buried systems.

The tunnel system cannot well be continued further north than



FIGS. 1 AND 2.—ELECTRICAL SUBWAYS AT THE WORLD'S FAIR, CHICAGO.

the Fisheries Building, because of the ground not being of sufficient height above water line. The tunnel systems will all be six feet high in the clear, except from the Manufactures Building to the Fisheries Building, where it can only be five feet.

It should be mentioned that other designs are being prepared for the structure of the tunnel, one of which may be preferable to the one illustrated; but in any case the arrangement of supporting conductors and the general dimensions will be maintained. It is not intended to construct the tunnels until the bulk of the lighting and power transmission is contracted for, so that modifications can be made to meet special requirements, if necessary. Manholes will be provided at intervals along the subway to enable the conductors to be placed therein with the greatest facility, and are necessary, since sewers and water-pipes cross the subway at several points, which will not, therefore, permit of walking from one end to the other, although the wires will be arranged in such a manner as to be got at without difficulty.

The facilities afforded by using a combination of the tunnel system, elevated railway structure and basement of buildings, as herein outlined, for the main trunk lines are considered adequate for supplying all the requirements of grounds and buildings, and the whole arrangement is extremely practical. The ease with which any of the wires can be got at is an important and meritorious feature of the plan, which reflects credit on the designer, and which has received the unanimous approval of, and been adopted by, the Committee on Electricity.

THE REAL VALUE OF ALUMINUM.

BY

During the past winter and spring several interesting and instructive papers upon the manufacture and characteristics of aluminum were read before scientific societies in this country, the tenor of which and of the discussions and press criticisms resulting therefrom very gravely emphasize the fact (which is well known to those practically familiar with its physical, chemical and electrical properties) that aluminum is a metal concerning which there have been more misconceptions and a greater display of ignorance than any other in common use.

Ever since the researches of Deville, Debrey, Fremy, Fissier Bros., and other investigators directed attention to its metallurgy and properties, aluminum has been the victim of romancers, who have enshrouded it in a halo so distorting that it is a matter of no small difficulty, even for those whose material interests call for an accurate and dispassionate estimation of its qualities, to determine just what are the actual merits of this so-called "*Silver from Clay.*" It is not, therefore, remarkable that the mass of our people should have received fallacious and exaggerated ideas concerning it, through the suggestions and not unfrequently absurd speculations of scientific as well as trade journals, and the daily press, in respect to the value and adaptability of this metal to the arts and industries. Such general ignorance in respect to a metal and the uses to which its qualities make it specially applicable is not only unfortunate from an educational standpoint, but very seriously embarrasses and retards the general utilization of the metal itself. It is always a sufficiently difficult and tedious task to introduce a new element into the usages of life, but in respect to aluminum the natural difficulties have been greatly enchanced; partly by this cause much more than by its hitherto limited production and consequent high price.

Recently trade competition has sprung up between the two most prominent producers of this metal in the United States, and one of them is publicly advertising "Aluminum equal in purity to any on the market at $.50 per lb., in any quantities," and this company is known to have contracted to deliver a considerable quantity, guaranteed to be of 99 per cent. purity, at that price. (It is rumored, however, that the company is endeavoring to recede from this contract, which was made by an over-zealous canvasser.) The other company, while publicly advertising aluminum, "guaranteed to be equal in purity to the best in the market, at $1.50 per lb., in ingots," is meeting the cut rate of its rival, though it does not appear what grade of metal it offers at the cut rate.

It is quite apparent that in this situation of affairs a large number of persons interested in manufacturing, or in the metal aluminum for experimental purposes, will avail themselves of this exceedingly low price to purchase considerable quantities of the metal, under the not unnatural supposition, derived from the tenor of the advertisements of the said companies, that they are securing PURE METAL. Finding, as they unquestionably will when they deal with aluminum below 99 per cent. purity, that it fails to meet—even approximately—in almost all particulars the descriptions of its merits and brilliant properties with which the press has been flooded, users will become prejudiced against it and by example and precept will induce others to condemn the metal, which, in fact, has not been tried on its merits at all. Such, as a matter of fact, has been the fate of aluminum bronzes and brasses, than which no more valuable metals are known to the industrial arts. The introduction of these alloys in this country and in Europe was unfortunately controlled by a company whose process, although possessing much merit, is well known to be incapable of producing alloys free from fatal contaminations or of uniform quality, even with such contaminations. This company having the entire field to itself for several years, and having invested large capital in plants here and in England, made every effort which an intelligent and unusually energetic management could make towards establishing its wares on the market. Their merits were widely advertised and commented on in the scientific and industrial journals, and a great many people and industrial companies bought more or less of them and some spent considerable capital in plants to work them. The result has been uniformly disappointing and the introduction of these alloys is currently believed to be a commercial failure, not because there was not a good demand for aluminum bronzes and brasses, and not because they had not the merits claimed for them when uncontaminated with iron and silicon and other impurities, but because the process of the said company was not equal to producing metal that could be relied upon either in the matter of purity or uniformity of strength. It is quite certain that years must elapse and much money and hard labor be spent in this country as well as abroad, before the pure aluminum bronzes and brasses will recover the market that was already made when the poorer metals aforesaid were placed before the public.

It therefore becomes a public duty as well as a matter of business interest to those engaged in the production of aluminum to warn purchasers against availing themselves of the present low prices and purchasing metal that is not absolutely guaranteed by responsible parties to be of at least 99 per cent. purity. Indeed, every such purchaser of aluminum in large quantities, or intending to use it for important purposes, should insist upon the additional precaution of having their metal re-analyzed. With these precautions and with the dissemination of accurate and precise knowledge of the constitution of aluminum and its alloys, and especially of the important and sufficiently radical transformation that takes place in the physical, chemical and electrical properties of those metals in the presence of apparently insignificant contaminations, this interesting metal will surely, although slowly, establish its true position in the industrial world as one of the most useful metals yet discovered. The truth of the whole matter is that, while, from the most unfavorable point of view, aluminum possesses more than sufficient intrinsic merit, properly understood and applied, to secure its extensive utilization as an important factor in our civilization, it is now distinctly suffering from the reactionary effects of over-booming.

In fact, it is at this time on trial, so to speak, in the commercial and manufacturing world, and it therefore seems proper that those having practical knowledge of the *bona fide* characteristics of the metal should utilize their opportunities to counteract, on the one hand, the illusions still generally existing as to its paramount importance in the metallurgical world, and, on the other hand, the scepticism as to its real merits that has followed the disenchantment of those who, impressed with the statements of scientific investigators, have sought, but failed to find in the impure metal of commerce, those valuable qualities which *do* exist in *pure* aluminum, but which are extinguished proportionally as contaminating substances are incorporated with it.

Curiously enough, the value of aluminum and its place in our daily life seems to have been forecast with wonderful accuracy in the opening lines of the work "1" Aluminum, by Deville, the father of the aluminum industry, and who has given us more knowledge on the subject than any subsequent investigator, wherein he predicted that, in an intermediate position between the precious and base metals, it was destined to fill a long-felt and important want. In the preface of the work, he says:

"The metals that men employ in civilized countries, for the ordinary needs of life, are very few in number; they are divided into two very distinct and different groups; precious metals and common metals. Gold and silver in the one, and in the other, copper, tin, iron, lead and zinc. Between the common and precious metals there does not exist an intermediate material. This blank which men have tried to fill by means of different alloys, which have been successively abandoned because of their price, and above all because of their inconvenience, remains in the most manifest and often the most inconvenient manner. Some years ago, when I attempted to discover some of the curious qualities of aluminum, my first thought was that I had put my hand on this intermediate metal, whose place would be in the uses and needs of men as soon as means should be found to bring it into common use. This provision seemed to be realized each day, and the actual state of the industry of aluminum gives perfect reason to the conclusion of my first memoir published at the beginning of 1855.

"Placed intermediate between the precious and common metals by some of its properties, it is superior to the first in uses of domestic life."

While this by no means justifies the enthusiasm of many of its would-be admirers, it does offer every reasonable encouragement to the efforts of those engaged in its production or utilization, to cheapen its cost *while increasing its purity*, and to develop new fields of industry, where its peculiar and unusual attributes will place it beyond rivalry by anything now known. In respect to its effect upon established industries it is quite safe to predict that in the very near future aluminum will be commercially produced of a purity almost, if not quite, equaling the purity of the best brands of copper, at prices that will place them in direct competition. Already aluminum can be had under a guarantee of 99½ and 99¾ per cent. purity, and the established qualities of the pure metal are such that, at slightly lower prices, it will, to a certainty, largely supplant copper in many applications to the arts and manufactures. Its alloys are already well known through actual use no less than by experimental tests to possess such exceptionally useful physical and chemical properties that there is little hazard in predicting their substitution for most purposes for which pure copper is now chiefly used. It is only necessary now that purchasers should not be deceived as to the supposed purity of their metal.

Society and Club Notes.

MR. A. R. FOOTE, BEFORE THE ELECTRIC CLUB, ON A MODEL NEW YORK CITY.

THE winter entertainment sessions of the club began on Thursday evening last, when Mr. A. R Foote, special agent for Electrical Statistics in the Eleventh Census, read a most interesting and suggestive paper on "The Making of a Model New York City." Mr. Foote began by calling attention to the urgent need in this city for rapid transit and said that the problem is "so to fix conditions that increase of population and increase of business shall cheapen instead of increase the cost of comfortable homes for wage-workers, and the tax on commerce and industry for its accommodations and services." In other words, New York wanted a service that would answer for a hundred years, alike for passenger and for freight traffic, providing cheap and good homes close to the factory where employment was given. It was not a solution of the problem to banish the wage-workers long distances into the country. Moreover, he said: "It seems strange that rapid transit for passengers should be the only thing talked about when all the improvements of the century have been devoted to that object, while freight traffic is handled in wagons on wagon roads, as was done one hundred years ago. Is it not time that this slow-moving endless procession of freight wagons should be notified that the quicker, cheaper and tireless forces of steam and electricity have been tamed to the service of transportation?" Mr. Foote's plan therefore, was not to tunnel under the city, not to penetrate the rural wilds of Jersey, but to re-occupy, to begin with, the river fronts on each side of the city. The space between the docks and the first and second streets from the water would be given up to a surface railroad and an electric railroad, and all the "squares" or blocks along this would be rebuilt with fine, solid structures running up eight or ten stories into the air. The surface roadway and the first stories of the docks and squares should be utilized entirely for freight or manufacturing, and in such wise that a car from any railroad can be switched into any dock, warehouse or factory on the route, on either side of the city. The elevated road and the second stories of the docks and squares should be utilized for passengers, warerooms, manufacturing and stores. All trains on all tracks should be run by electric locomotives. Along the lower roadways provision should be made for sewage, gas, water-pipes, etc. The roadways above should be flanked their entire length by broad, well-protected sidewalks, always open to the public. A similar walk should extend around each story. Each "square" would be provided with every convenience of communication, comfort, sanitation, etc. The buildings being of uniform height would carry all the wires at their tops on standards. Every building would have its electric elevator, and while heavy electric power machinery would run the big factories on the lower floors, small electric motors would supply power to the homes on the upper floors, so that for fifty cents a month every man could do his own work in any ordinary trade and thus be his own master. For furnishing electric power and heat, or steam heat, if needed, there would be generating plants at proper intervals. If this plan were carried into effect, said Mr. Foote, it would wipe out the tenement house evil in New York city. "If 'squares' are carried up seven or eight stories, the floor space created will far exceed the present floor space of the entire city. The capacity of the warehouse and manufacturing premises will exceed that of any city in the world." Mr. Foote then went on to point out the various gains to the public, the wage-worker, and the nation. The main obstacles were the real estate titles and the existing ramshackle buildings, and while he would fairly compensate for all actual values destroyed, he would not let the selfishness of any owner stand in the way. "His defects of character should not be given a cash value." A competent commission with power to issue 3 per cent. 100-year bonds could carry out the whole work, and he believed it could be made a handsome investment. It would, moreover, do much for the commercial supremacy of New York. "By properly arranging hoists, traveling cranes, turntables, tram cars and signals, all operated by electrical energy, two or three intelligent workmen can handle freight without the use of their own physical strength, in bulk and weight so great that all the human hands that can be laid upon it, exerting their utmost strength, would not be able to move. A skilled workman using power-driven machinery under the conditions described can command electrical energy equal to his own physical strength for less than five cents a day. More than this, his intelligence can direct the effective energy of a hundred or a thousand men, so that his own wages, added to the cost of the energy used, will make his labor cheaper than that of the unintelligent unaided man at five cents per day." Under these conditions the cost of handling material in New York City would be reduced to the minimum. Mr. Foote concluded with the remark: "The best opportunity the present generation will have so to arrange economic conditions is included in the demand for rapid transit. This is a demand for a freer, larger life. It calls for the abolishment of old ways, and the providing of new ways, not only for the transportation of persons, but for the entire management of commerce, communications and industry."

At the close of Mr. Foote's paper, Mr. Erastus Wiman, vice-president of the Club, who was in the chair, made a most able and eloquent comment on it and on the conditions it dealt with, expressing his belief that it indicated a feasible and practicable solution. He was followed by Dr. A. F. Mason, of Boston, who suggested crowning the squares with gardens for the benefit of the children. He did not know the exact manner in which the problems touched on would be dealt with, but he did know that the modern worker would not be satisfied to remain under existing conditions, but would insist on living in closer approximation to all that the higher sentiment and knowledge of the day showed to be best for humanity.

Mr. Foote presented the Club with a finely bound volume of the "Electrical Schedules of the Census," and the vote of thanks to him for the gift expressed the hope that nothing would be allowed to interfere with the completion of the work therein laid out.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

AT the meeting of the Council of the Institute held Sept. 22, 1891, the following gentlemen were admitted to associate membership in the usual course:

Caldwell, Fordyce S., proprietor Western Electric Construction Co., 503 Delaware St., Kansas City, Mo., and 150 West 82d St., New York City.

Cartwright, Fred'k G., Electrical Engineer, and Agent Fort Wayne Electric Co., 35 New Montgomery St., San Francisco, Cal.

Cheney, W. C., Electrical Engineer, Willamette Falls Electric Co., Portland, Oregon.

Foote, Charles W., Agent Railway Dept., Thomson-Houston Elec. Co., Society for Savings Bldg., Cleveland, O.

Hall, John L., Manager Western Union Telegraph Co., 300 Market St., Wilmington, Del.

Hamilton, William H., Dealer in Electrical Supplies, 200 State St., Albany, N. Y.

Hosford, Henry H., Electrical Engineer, 1009 Society for Savings Bldg., Cleveland, O.

Land, Frank, 606 Salina St., Syracuse, N. Y.

MacMullan, Robert Heath, Treasurer and General Manager, Brush Electric Lighting Co., Lafayette, Ind.

Marple, Lucius E., Electrician, United Electric Railway, Nashville, Tenn., and Wollaston, Mass.

Mordey, Wm. Morris, Electrician, Brush Electrical Engineering Co., 34 Montserrat Road, Putney, London, Eng.

Morss, Everett, Electrician, Simplex Electrical Co., 297 Beacon St., Boston, Mass.

Pattison, Frank A., firm of Pattison Bros., Consulting and Constructing Electrical Engineers, 135 Broadway, New York City.

Rogers, Edward H., Patent Lawyer, firm of Pope & Rogers, 15 Wall St., New York City.

Rutherford, W. M., Electrical Engineer, Thomson-Houston International Electric Co., 620 Atlantic Ave., Boston, Mass.

Schlosser, Fred. G., Superintendent of Electric Dept., Laclede Gas Light Co., 1801 Washington St., St. Louis, Mo.

White, Geo. Montagu, Agent for West Indies, Thomson-Houston International Electric Co., Kingston, Jamaica, W. I.

The following report was presented:

REPORT OF COMMITTEE ON UNITS AND STANDARDS.

Your committee, considering that authorized and recognized names for four practical electromagnetic units, at present unentitled, are needed by electrical engineers in this as well as in other countries, for dealing conveniently with magnetic circuits in analysis, discussion, and design, recommends to the Institute the four units as appended in detail, of magneto-motive force, reluctance, flux, and flux-density, in the hope that if favorably considered, the Institute may further the endeavors of the next International Electrical Congress towards securing for them universally recognized titles.

A. E. KENNELLY,
Chairman.

LIST OF NEW UNITS PRACTICALLY NEEDED FOR CONVENIENCE IN DEALING WITH MAGNETIC CIRCUITS.

1st. *Magneto-Motive Force;* or difference of magnetic potential.
Simple Definition.—The analogue in a magnetic circuit of voltage in an electric circuit.
Strict Definition.—The magneto-motive force in a magnetic circuit is 4π multiplied by the flow of current linked with that circuit.
The magneto-motive force between two points connected by a line, is the line integral of magnetic force along that line. Difference of magnetic potential constitutes magneto-motive force.
Electromagnetic dimensional formula, $L^{1/2} M^{1/2} T^{-1}$.

The absolute unit of M. M. F. is $\frac{1}{4\pi} \times$ unit current of one turn.

The practical unit is $\frac{1}{4\pi} \times$ ampere of one turn, or one-tenth of the absolute unit—*i. e.*, 0.0796 ampere-turn gives the unit. The prefix kilo- would perhaps be occasionally used for practical applications.

2d. *Magnetic Flux.*
Simple Definition.—Total number of lines of force or total field.
Strict Definition.—The magnetic flux through a surface bounded by a closed curve, is the surface integral of magnetic induction taken over the bounded surface, and when produced by a current is also equal to the line integral of the vector potential of the current taken around the boundary.
The uniform and unit time rate of change in flux through a closed magnetic circuit, establishes unit electromotive force in the circuit.
Electromagnetic dimensional formula, $L^{3/2} M^{1/2} T^{-1}$.
The absolute unit is one C. G. S. line of induction.
The practical unit is 10^8 C. G. S. lines.
Fluxes range in present practical work from 100 to 100,000,000 C. G. S. lines, and the working units would perhaps prefix milli- and micro-.

3d. *Magnetic Intensity,* or induction density.
Simple Definition.—Flux per sq. cm.
Strict Definition.—The induction density at a point within an element of surface is the surface differential of the flux at that point.
Electromagnetic dimensional formula, $L^{-1/2} M^{1/2} T^{-1}$.
Absolute unit, one C. G. S. line per sq. centimetre.
Practical unit, 10^8 C. G. S. lines per sq. cm.
In practice, excluding the earth's field, intensities range from 100 to 20,000 lines per sq. cm., and the working unit would perhaps have the prefix milli- or micro-.

4th. *Magnetic Reluctance.*
Definition.—Unit reluctance in a magnetic circuit permits unit magnetic flux to traverse it under the action of unit magneto-motive force.
Dimensional formula, $L^{-1} M^0 T^0$.
The practical unit is 10^{-9} the absolute unit.
Reluctances vary in present practical work from 100,000 to 100,000,000 of these practical units, so that the working unit would perhaps employ the prefix mega-.

Appointments, Etc.

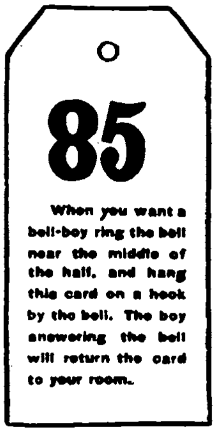
MR. J. M. STEPHENS, for many years manager of the Western Union telegraph office at Atlanta, Ga., has been appointed superintendent of the Fourth District, to fill the vacancy caused by the death of Mr. C. G. Meriwether.

MR. F. O. RUSLING, late of Wichita, Kan., and St. Joseph, Mo. has been appointed general superintendent of the electric railway at West Bay City, Mich. Mr. Rusling has had an electrical experience of eleven years.

H. B. SMITH has been appointed Professor of Electrical Engineering in the Arkansas State University.

Letters to the Editor.

A NOVEL HOTEL ANNUNCIATOR CALL SYSTEM.



I AM sure the readers of THE ELECTRICAL ENGINEER will be interested in the accompanying card, which constitutes a part of the novel hotel annunciator call system discovered by me in the wilds of Michigan during a recent trip to Traverse City. The card enclosed belonged in room 85, and I think I am, or should be, free from the charge of petty larceny for the service I am doing to mankind in disclosing this system to the world through your valuable journal.

C. J. KINTNER.

NEW YORK, Sept. 12, 1891.

UTILIZING THE LACHINE RAPIDS.

HAVING resided in Montreal for several years and being acquainted with its local peculiarities, I wish to call attention to a circumstance that has not been mentioned in the recent comments upon the water power, now apparently going to waste at the Lachine Rapids, near that city.

Although these rapids of the St. Lawrence carry more water than passes over the falls at Niagara, the fact must not be overlooked that for a few days in the early part of the winter when the ice-bridge is forming on the river opposite the city, and again in the spring when it is breaking up, the river below the rapids gets choked up with ice. This dams up the water, causing it to rise to such a height as to partly, and frequently almost entirely, neutralize any power obtained from the rapids.

This is undoubtedly the principal cause that interferes with the utilization of these rapids, as any electric or other plant deriving its power from this source would be obliged to shut down partially, if not entirely, twice a year during these periods, unless it followed the example of the Montreal City Corporation, which, at its water works, employs power from the rapids to pump water up to reservoirs on the mountain, but uses the steam engines of an auxiliary steam plant when the water power is not available.

LOUIS M. PINOLET.

Brooklyn, Sept. 17th, 1891.

DECREASE IN RESISTANCE OF LIQUIDS WITH INCREASE OF TEMPERATURE.

IT is a well-known fact that the resistance of liquids varies inversely with the temperature. I am not aware that any satisfactory explanation of this has been given, but it seems to me that it can be accounted for in the heat of combination. As the temperature is increased, the energy between the atoms of the molecules becomes less, and it may be that this energy really constitutes the opposing force of the current. The counter E. M. F. of an electrolyte should, therefore, be decreased by an increased temperature. This could be taken advantage of in practical electrolysis by heating the baths with waste steam, etc. If any of your readers can make any suggestions on the subject, it might be productive of good results.

JOSEPH W. HARRIS.

ORANGE, N. J.

NOTE.

THE practical utilization of the gain in conductivity of electrolytes by heating them is not a matter of recent discovery. It would be difficult in fact to trace back the date of its earliest use. The writer first had his attention called to it in 1876, at which period the heating of the electrolyte in an electrolytic operation was first used in this country by Mr. N. S. Keith, in connection with his electrolytic tin-scrap process for the detinning of scrap. About 1880 and for some years later, the writer had practical experience with this application of heating in connection with Mr. Keith's process for the electric desilverization of lead base bullion. In this process the temperature was maintained at a uniform degree, ranging up to 130 deg. Fahr. The gain in conductivity was considerable.

In Europe, also, it is the practice to use heat for increasing the conductivity of solutions in electro-metallurgical operations. In the case of processes for refining, the temperature can be regulated without great difficulty, as the current density is usually somewhat low, and the heat due to the passage of the current itself ($C^2 R$) is not a disturbing factor of so much importance.

However, in the case of electrolysis used in connection with the deposition of metals in the arts, for electroplating, electrotyping—particularly the latter—where a much greater current density is used, the heat due to the passage of the current itself is sufficient to maintain the temperature at approximately the desired point and thus automatically increase its conductivity. The writer has seen cases, in his own experience, where extreme speed of deposition was sought and realized, and wherein it became actually necessary to provide means for cooling the solution, even though the specific resistance of the solution had been reduced as far as possible by the proper chemical means; and its working resistance reduced by diminishing the distance between the electrodes. That is, the total heat due to the current ($C^2 R$) was greater than that which the surface evaporation, conduction, convection, etc., could carry off so as to maintain the temperature below practicable working limits.

In any electro-deposition process, involving the use of wax matrices, the limiting temperature is much more quickly reached. The heat will also be greater in the summer than in the winter, for obvious reasons.

The use of heat in electro-deposition was probably resorted to in this country even before the date above mentioned—1876—in connection with processes for depositing nickel, though in that case it may have been employed as much for chemical reasons as for electrical.

C. O. Mailloux.

"MINIMUM FIRST COST OF PLANT AND MAXIMUM ECONOMY OF OPERATION IN THE ELECTRICAL TRANSMISSION OF POWER."

BY

Chas. J. Reed

In The Electrical Engineer of Sept. 2, 1891, Mr. H. Ward Leonard made some remarkable statements, which, on account of the importance of the subject to a large class of prospective investors, and the recognized authority of Mr. Leonard in such matters, should not, it seemed to me, be allowed to pass without correction. I therefore called Mr. Leonard's attention to the matter and invited him to explain more clearly what seemed to me manifest errors. I regret that Mr. Leonard in his courteous reply published the 23d inst., has failed to make his position any clearer; but by a kind of circumduction has left the impression that my criticisms were not well founded.

If Mr. Leonard's conclusions are true, they are of sufficient importance to the public to go into the details, giving the reasons for his assumptions. If they are not true, it is equally important to a large and interested class to know it. For these reasons I again challenge Mr. Leonard, through the indulgence of The Electrical Engineer, to show his proofs.

He starts out with an arithmetical error and in his reply adheres to the error, insisting that it is correct. I will call his attention to it specifically. In his expression for the weight of the conductor he uses M, the area of 2 D as a factor, and then introduces the factor, "2," again, giving the weight of a conductor 4 D in length.

Mr. Leonard begins by saying: "*I shall first treat the subject generally and deduce the correct laws.*" If this does not mean that his formulæ are to be considered general, what does it mean? He then arbitrarily assumes variable conditions to be fixed and the absurdity of his conclusions is manifest. His explanation of equations (12) and (13) is not lucid. If these equations mean anything, they mean just what they say, viz., that under conditions of minimum cost of plant, the cost of conductors increases with the loss in conductors and depends only on the loss and cost of translating devices—an absurdity so obvious that it is unworthy of discussion. The reassertion, without proof, that the minimum first cost is independent of the price and conductivity of the conductor, is not convincing and not calculated to inspire confidence in Mr. Leonard's conclusions. If this is true, we might go a step further than using gold for conductors. We might use clay or wood! The conditions of minimum first cost would not be altered!

But the statement is *not* true. The condition of minimum first cost would be very different, for instance, with copper at one cent, and at one dollar, per pound, except in the particular case in which the weight of copper in conductors is to the weight of copper in the generators and accessories in such a relation that a variation in distance, electromotive force, or loss in transmission would not alter the total weight of copper employed—a condition that would be difficult to realize.

With any increase in the price of copper the mininum cost of plant would require smaller conductors, larger generators and greater loss in transmission or greater electromotive force, for all distances greater than that at which the weight of copper in conductors equals the weight of copper in the generators and accessories. For distances so small that the weight of conductors is less than the weight of copper in the generators the opposite conditions would obtain. Of course, for such small distances variations in the price of copper would, in practice, be ignored; but according to Mr. Leonard's assumptions the conditions of minimum cost (electromotive force, loss, relative size of generators and conductors, etc.,) would be the same whether the cost of conductors be equal to that of the generators or a thousand times greater.

The problem of determining the minimum first cost of a plant for the electrical transmission of power does not depend on any one or two conditions, but on many. Among the conditions that independently affect this cost are distance, conductivity of conductor, price of conductor, price of generator and accessories, price of power-generating machinery, and price of labor in construction. Among those that affect it dependently are electromotive force of transmission and loss in transmission.

The market value and physical properties of copper render it the only available material at present for conductors, and hence we may assume the conductivity to be constant and it needs no further attention. It is not so, however, with the price. The conditions of minimum cost would not be the same, as shown above, with copper at one cent, and at one dollar, per pound.

In order to bolster up his conclusions and show that Thomson's law is not practicable, Mr. Leonard offers the following unique example:

"*Let us suppose that the interest and depreciation upon our plant is $9 per annum per kilowatt delivered; also, that the value of one kilowatt is $5 per annum!*" In this case I should prescribe the same remedy as I would for a merchant who proposed opening a store where he would pay $9 per day rent and sell goods amounting in value to $5 per day. If $9 are expended per annum in interest and depreciation alone per kilowatt (to say nothing of fuel and operating expenses), how could the product be worth only $5 per kilowatt, especially if it were produced under conditions of "minimum first cost of plant and maximum economy of operation?"

THE IMPORTANCE OF THE POINT OF VIEW FROM WHICH THE TRANSMISSION OF POWER IS REGARDED.

BY

H. Ward Leonard

I have read the article of Dr. Cary T. Hutchinson, which appeared under the above title in The Electrical Engineer of September, 23, 1891. The article attempts a defense of the rules laid down by Mr. Sprague in his article on "The Transmission of Power by Electricity," which appeared in the *Journal of the Franklin Institute*, of March-April, 1889, and also attempts to show that in my recent article I made serious errors by misinterpreting Mr. Sprague's rules. I should feel inclined to delay replying to Dr. Hutchinson's points, if I thought that Mr. Sprague, or others, were likely to raise additional points which I could consider at the same time; but realizing that Dr. Hutchinson is at present intimately associated with Mr. Sprague in business, I shall assume that Dr. Hutchinson's present article gives expression to Mr. Sprague's views.

Dr. Hutchinson endeavors to show that, in reality, Mr. Sprague's deductions and mine are identical in effect, and by making certain plausible assumptions he finally, apparently, proves that Mr. Sprague's conclusions and mine are exactly the same. That Dr. Hutchinson's article is a masterpiece of ingenuity in disguising the assumptions made and in cleverly interpreting in an unexpected manner a perfectly positive statement made in the most definite language, I am bound to admit, and I think the article certainly demonstrates in one way "the necessity of looking at every question from all sides before making positive statements." The positive statements which I refer to are the two principal rules which Mr. Sprague lays down, and which are as follows:

1. "With any fixed conditions of cost and efficiency of apparatus the number of volts fall to get the minimum cost of plant is a function of the distance alone and is independent of the electromotive force used at the motor."

2. "With any fixed couple and commercial efficiency the cost of the wire should bear a definite and fixed ratio to the cost of the generating plant."

Although it seems impossible to find but one meaning for these rules, as laid down by Mr. Sprague, yet Dr. Hutchinson has skilfully pointed out a way to do so. It will be evident to those familiar with the calculation of conductors that, stated as above, the rules are very misleading and entirely incorrect. A few practical applications of the rules will satisfy anyone on this score.

The first rule states that if we have fixed conditions of cost and efficiency of apparatus and also have a fixed distance, the volts fall for minimum cost, being a function of the distance alone, will also become fixed. Suppose we determine the volts fall in this way for any case. Is it not evident that, whatever the cost of the conductor may be, we can reduce such cost by increasing the volts fall, and yet, by increasing the E. M. F. at the motor proportionately, keep the cost of apparatus the same as before, and hence effect a reduction in the total cost?

From rule 2 we learn that if we fix the commercial efficiency, the cost of copper for minimum cost of plant will also be fixed. With any fixed commercial efficiency the cost of apparatus is fixed, but not so the cost of copper; for we can preserve the commercial efficiency constant and yet, by increasing both the volts fall in the line and the E. M. F. at the motor in the same proportion, reduce the cost of conductor indefinitely and hence can reduce the total cost of plant.

Dr. Hutchinson claims that I interpret these rules incorrectly and would have us interpret them, as follows:

1. With fixed conditions of cost, efficiency of apparatus *and electromotive force at motor*, and *under* conditions of minimum first cost of plant the number of volts fall is a function of the distance alone, and is independent of the E. M. F. used at the motor.

2. *Under conditions of minimum cost* and with any fixed couple and commercial efficiency the cost of the wire *bears* a definite and fixed ratio to the cost of the generating plant.

I think any reader will readily see that the revised rules are radically different from those announced by Mr. Sprague. Mr. Sprague's comment regarding his first rule was, "a somewhat startling conclusion," but it will be noticed that the injection of the various conditions Dr. Hutchinson desires, takes all the "startle" out of the conclusion.

Any reader of Mr. Sprague's second rule would suppose that if we have a fixed couple and commercial efficiency we should, in order to operate at minimum first cost, have a cost of wire which would bear a definite and fixed ratio to the cost of the generating plant. But this now being manifestly incorrect, Dr. Hutchinson assures us that it means, that if we, in some way, find out how to operate under conditions of minimum first cost, we will observe that then the cost of the wire does, under such conditions, bear a definite and fixed ratio to the cost of the generating plant—an entirely different statement.

Since it is evident that Dr. Hutchinson can readily insert enough conditions and enough assumptions to make Mr. Sprague's rules give a correct result, it will perhaps be more conclusive to learn from Mr. Sprague himself exactly what he did mean when he laid down these rules. Mr. Sprague's article itself furnishes us clear evidence on this point. He says: "For example, suppose we wish to transmit 20,000 feet. The fall of potential on the line could be 362 volts, and this is independent of the commercial efficiency. If this latter is made, say, 60 per cent., then *E* (E. M. F. at motor) equals 1,086 volts and the potential at the terminals of the generator should be 1,448 volts."

It is evident from the above that Mr. Sprague overlooked the fact that it would be possible to maintain a commercial efficiency of 60 per cent., and hence keep the cost of apparatus constant, and yet, by raising both the volts drop and the motor E. M. F., reduce the cost of copper indefinitely, and that hence he has not correctly stated the minimum conditions. In fact, there could be no practical minimum conditions for the case assumed.

Dr. Hutchinson wonders whether I have really read Mr. Sprague's article. I beg to remove his doubts on this score, and also to say that, thinking that possibly Mr. Sprague had noticed his errors and corrected them in later articles on the same subject, I carefully examined another, later, paper by Mr. Sprague, published in the *Scientific American Supplement*, of July 20-Aug. 3, 1889, and found the same erroneous interpretation and statements, as is evidenced by the following quotation: "For example, suppose we wish to transmit a distance of 30,000 feet at a commercial efficiency of 60 per cent. What would be the required E. M. F. at the motor terminals? We find the E. M. F. to be 1,620 volts."

In conclusion I beg to acknowledge my error in ascribing to Mr. Sprague the rule given by Mr. Badt on page 42 of his handbook, which apparently is his own. I was led into this error by the fact that Mr. Badt did not use quotation marks in the case of any of Mr. Sprague's rules, but gave a foot-note on page 10, saying, "The rules in italics are taken from Frank J. Sprague's papers mentioned in the preface." This rule being in italics, I assumed it to be one of Mr. Sprague's, and did not take the precaution of comparing it, especially as it seemed consistent with Mr. Sprague's rules quoted above.

I think it will be seen from the above that I did not, in my article, place any different interpretation upon Mr. Sprague's rules than that which he himself clearly gives to them; I will gladly and promptly admit any other error on my part, besides that above acknowledged, if it be pointed out to me.

HOWARD'S IMPROVED TELEPHONE APPARATUS.

SOME recent improvements and modifications in telephonic apparatus have been devised by Mr. James H. Howard, of the Tropical American Telephone Co., of Boston, and will prove of interest, as they aim at the removal of some of the retarding influences met with in telephony.

In order to effect the cutting out of the receiver when it is hung up, and at the same time allow the current on the primary circuit to pass around the Siemens armature of the magnets when not in use, Mr. Howard has designed the arrangement shown in the accompanying diagram, Fig. 1.

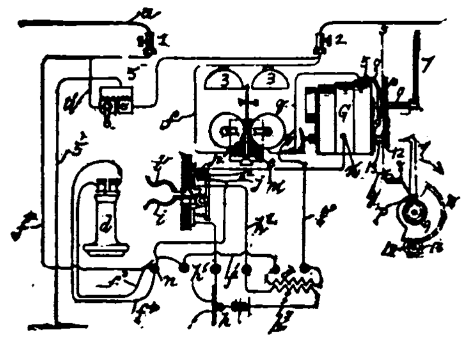
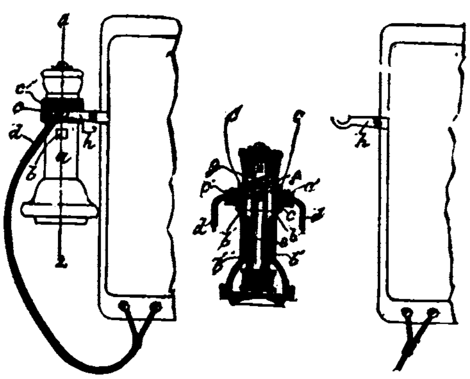


FIG. 1.

It will be seen that when the receiver is off its hook and the telephone is in use, the current follows the main line *b*, the wire *f* connected through the bell-magnet *e* to wire *f'*, through the induction-coil *g*, connecting-wires f^2 and f^3, receiver *d*, wire f^4, wire f^5, and so on to the main line *a*, with which the wire f^5 connects at 1. When the receiver is in this position, the secondary or induced current may be traced from the microphone or transmitter *h* through wire *h'* to a terminal connected with one arm *i* of the hook or crotch which supports the receiver *d* when the same is hung up, from the arm *i* to the other arm *i'* of the hook, thence by wire h^2 through the induction-coil *g*, and by wire h^3 to the transmitter *h*. Thus, when the telephone is in use the armature is cut out of circuit and its resistance and retarding influence is removed.

It will also be noted that the call-bell is operated by a lever 7 which is attached to a spindle carrying a toothed sector 10, gearing with the armature shaft; the crank shaft *o* also has a disc 9 mounted on it and insulated on its periphery, except at one point. When the receiver *d* is on its hook the current comes over the main line *b*, wire *f*, through the bell-magnet *e*, wires *q'* and *q* to contact-piece 8, and disc 9, through the frame of the armature to wire *m'*, through terminal *j'*, contact-maker i^2 and terminal *j* to wire *m*, and thence through wire f^5 onto the main line *a*. It will thus be

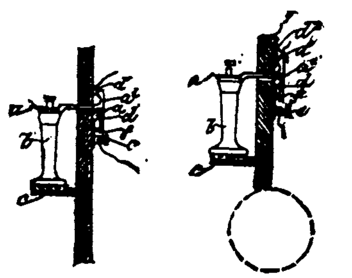


FIGS. 2, 3 AND 4.

seen that the current avoids the resistance of both the armature and the telephone-receiver when the latter is upon its hook and the armature is at rest, both being cut out of the circuit. The bell is caused to ring by moving the crank 7, this movement cutting the wire *q* and contact-piece 8 out of the circuit, the current then passing through the wire *q'* and contact-spring q^2, through the coils of the armature, and so on to the wire *m'* in the usual way.

The calling crank is brought back to its normal position by a coiled spring, so that one, or any number of signals, can be given with ease and certainty, where several stations on a line require a different number of rings or calls for each. It also does away with electrical connection with the ringer through the door-hinges, leaves the door free so that no hinges are required, three or four wood screws replacing them, besides providing a convenient place for a directory of those subscribers' numbers most used. The lightning arrester is a simple 2-point switch on the side of the call-bell, where it can be readily seen and operated, and the liability of losing the present crude lightning-arrester pin is obviated. The side crank, telephone support and gongs take up less space and are less liable to injury in packing and shipping, especially for export.

Mr. Howard has also devised a telephone receiver which embodies in its own construction the switch which cuts out from the circuit the coil of the receiver when the latter is not in use. The construction and operation of this apparatus is shown in Figs. 2, 3 and 4. It will be seen that when the receiver is detached from its hook, the conducting portions of the ring *c*, carrying the circuit-wires *d d*, make contact with the pieces *b b*, the current thus flowing through the coil of the receiver, the wires b' b^2 of tht coil forming the only conducting connection between the circuit-wires *d d*. When, however, the receiver is hung upon its hook, *h*, the arms c' resting on the hook, the weight of the receiver is such as to overcome the stress of the spring *g*, and the receiver moves slightly downward through its closing ring *c*, which is supported by its arms c' on the hook *h*, thus breaking the contact between the ring *c* and the contact-pieces *b*, connected with the coil of the receiver. Contact is then made between the conducting portions of the ring *c*, carrying the wires *d d* by means of the hook *h*, the arms c' c' resting on the arms of



Figs. 5 and 6.

the hook. It will be seen that the current then flows from one wire *d* to the other through the hook *h*, thus cutting out the coil of the receiver and avoiding its resistance.

Two nails, driven in the wall, between and on which to hang the phone, will suffice, with this device, to cut out the phone, and a 2-point switch, worth 50 cents, would cut in the ringer circuit of any call-bell, or this can be done by a simple circuit-closer on the telephone, as shown, called into action when the receiver is hung up.

Figs. 5 and 6 represent an improved hook, so arranged as to prevent the current passing through the receiver when on the hook. When the receiver *b* is not in use, its upper end is inserted under the arms *a a* of the hook, and the same are moved upwards until the lower end of the receiver rests upon the shelf *c*, as shown in Fig. 5, thus moving the upper end of the cross-piece a^2 away from the contact-piece d' and breaking the circuit at that point. When the receiver is again removed from its shelf *c*, the spring *f* again presses the cross-bar a^2 against the contact-piece d', thus completing the circuit. As shown in Fig. 6, a second contact may be arranged behind the upper end of the lever or the cross-piece a^2, as at d^2, to which may be connected a wire of a second circuit, which would be cut out when the receiver is removed. This arrangement could also be made to cut out the ringer or generator circuit.

Personal.

FRED. H. WHIPPLE.

The Electrical Engineer has for some time been receiving, from several sources, reports of very irregular money transactions on the part of Mr. Fred. H. Whipple, of New York and Detroit, implying methods so objectionable as to suggest a word of caution to electrical circles generally. We are informed of a number of dishonored drafts cashed for Mr. Whipple by gentlemen in electrical business, some of which have been held for several months and remain unpaid. We are not inclined to impute dishonesty to Mr. Whipple, but the effect of transactions of the kind referred to, even if due to carelessness, must be to diminish confidence in him.

Mr. John W. Lieb, the electrical engineer of the celebrated Milan, Italy, electric light station, is now visiting this country.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED SEPTEMBER 15, 1891.

Accumulators :—

Method of Making Plates for Secondary Batteries, S. C. C. Currie, 459,491. Filed Jan. 24, 1891.
Consists in converting electrolytically cast or rolled lead, enveloped or enclosed in asbestos or analogous material in a solution composed of a chloride of a metal, to a soft state ; then reducing the same to a spongy or porous metallic condition.

Secondary Battery, W. L. Silvey, 459,535. Filed June 27, 1891.
Process of preparing consists in mixing a suitable metallic oxide with water, placing the resulting paste on a suitable support and then pickling the whole in an acid solution.

Alarms and Signals :—

Till-Alarm, H. Garrett, 459,442. Filed Nov. 13, 1890.

Electrical Alarm System, J. P. McMahon, 459,501. Filed Jan. 24, 1891.
Improvement upon the system of the same inventor patented Dec. 3, 1889, No. 416,483. Applicable to fire-alarms and similar service.

Electric Push, J. F. Wollensak, 459,605. Filed Jan. 28, 1891,

Annunciator, F. Ritchie, 459,615. Filed Dec. 29, 1890.

Conductors, Conduits and Insulators :—

Conduit for Electric Wires, H. W. Johns, 459,509. Filed Apr. 27, 1891.
A seamless woven, knitted, or braided tube made from fire-proof strands of fibrous material and having an exterior coating of protecting and strengthening material, such as metal.

Cable-Box for Electric Wires, J. N. Keller & J. A. McCoy, 459,523. Filed May 23, 1891.
Relates especially to methods of partial or way distribution of conductors, and to arrangements for cross-connections.

Distribution :—

System of Electrical Distribution, E. Thomson, 459,423. Filed Dec. 19, 1890.
Regulates a continuous current transformer by subjecting a separate armature conductor, in circuit with a main winding of the transformer, to the action of an auxiliary magnetic field acting only on said separate conductor and varying the strength of said auxiliary field.

Dynamos and Motors :—

Dynamo-Electric Machine and Motor. E. Thomson, 459,422. Filed Oct. 31, 1885.
The armature core is provided with narrow slots extending longitudinally or parallel to the axis of the core and radially toward the centre of the core, but passing only part way through the iron of the core, leaving that portion of the iron close to the shaft continuous and unslotted. Employs independent magnetizing helices, one of which acts upon the portion of pole-piece next the diameter of commutation and is included in the main circuit.

Dynamo-Electric Generator or Motor, J. Hodult, 459,508. Filed May 23, 1891.
Designed for operation with either alternating or continuous currents.

Dynamo-Electric Machines, E. Desroziers, 459,610, Filed June 17, 1887.
Relates especially to a dis: armature for multipolar machines.

Electric Motor. J. W. Davis & J. B. Farrington, 459,678. Filed May 5, 1891.
Operated by static charges. Especially adapted for the use of students and for experimental purposes.

Electrolysis :—

Process of Electrolytically Obtaining Zinc, A. Watt, 459,556. Filed Mar. 22, 1889.
Claim 2 follows:
The improvement in the art of preparing zinc-bearing ores for electrolysis, which consists in digesting the powdered ore in acetic acid and sulphuric acid, at first separately and afterward jointly, to form an electrolyte.

Galvanic and Thermo-Electric Batteries :—

Fibrous Carbon Battery, J. H. Robertson, 459,447. Filed Nov. 17, 1890.
The negative element consists of fibrous carbon made from rattan.

Lamps and Appurtenances:—

Electric Switch, B. W. Allen, 459,465. Filed Nov. 6, 1890.
A device whereby one or more electric lamps may be lighted or shut off by one and the same switch, without regard to their number or location.

Electric Arc Lamp, E. R. Knowles, 459,510. Filed May 25, 1891.
Relates to regulating mechanism. A rack and pinion feed is employed.

Incandescent Electric Lamp Socket, J. O. Phillips, 459,514. Filed Dec. 3, 1890.

Electrical Fixture, E. T. Greenfield, 459,704. Filed Dec. 31, 1890.
Relates to switch or ceiling blocks for use in incandescent lighting and similar purposes.

Electric Light Fixture, E. T. Greenfield, 459,705. Filed Dec. 31, 1890.

Medical and Surgical :—

Electric Belt, C. H. Dorenwend, 459,681. Filed Sept. 16, 1890.

Miscellaneous :

Cut-Out, F. Bryan, 459,560. Filed Mar. 11, 1891.

Apparatus for Working Punkas, H. E. Walter, 459,663. Filed May 19, 1891.

Electric Snap-Switch, G. W. Hart, 459,706. Filed June 22, 1891.

Railways and Appliances :—

Railway Danger-Alarm, D. J. Haynes and O. Allen, 459,456. Filed Sept. 16, 1890.
Designed to indicate the destruction of a culvert or bridge.

Trolley-Wire Connection, R. L. Caldwell, 459,485. Filed June 10, 1891.

Trolley-Wheel, G. E. Lewis, 459,588. Filed Dec. 20, 1980.

Railway-Signal, H. C. Horstmann, 459,638. Filed May 15, 1891.
For block systems. A train entering a block causes the display of visible signals throughout the entire block, and also indicates the direction of the train.

Insulator, C. L. Gerrard, 459,686. Filed April 8, 1891.
Trolley wire insulator.

Slide-Shoe Trolley, S. H. Short, 459,689. Filed April 15, 1890.

Rheostat for Electric-Motor Cars, S. H. Short, 459,690. Filed Mar. 18, 1891. Composed of exposed strips of low conductivity, mounted and extending upon the roof of the car.

Safety Cut-Out for Overhead Wires, N. Froloff and W. Subbotin, 459,721. Filed Feb. 7, 1891. For trolley wires.

Telegraphs:—

Telegraphic Apparatus, W. E. Sloan, J. E. Hughes and O. S. Reed, 459,448. Filed July 5 1890. A pneumatic telegraph with local electrical devices.

Telephones and Apparatus:

Fastener for Spring-Jacks of Switch-Boards, C. E. Scribner, 459,711. Filed May 7, 1891. Relates to switchboards for telephone exchanges.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED SEPT. 22, 1891.

Alarms and Signals:—

Burglar Alarm, H. T. Wilson, 459,984. Filed Feb. 8, 1891. Relates to floor contacts.

Electric Show Case Alarm, R. C. Kruschke, 460,019. Filed Dec. 1, 1890.

Conductors, Conduits and Insulators:—

Automatic Disconnector for Overhead Conductors, A. L. Johnston, 459,-839. Filed Jan. 19, 1891. For improvements on same inventor's device patented Aug. 26, 1890, No. 455,098.

Insulator, V. A. Thomas, 459,843. Filed Nov. 22, 1890. A tree insulator.

Electric Cable, D. Brooks, Jr., 459,941. Filed Jan. 14, 1891. A flexible joint.

Electric Coupling, F. M. Farwell, 460,048. Filed Jan. 27, 1891. Adapted for electric connections on railway trains.

Process of Manufacturing a Composition Applicable for Electrical Insulating Purposes, etc., E. Fahrig, 460,056. Filed July 18, 1890. Mixes and beats up a pulp staff with manilla or other similar fibres, then adds a soap solution, then treats the resulting mass with a precipitate until the precipitate shows itself in the mass, then forms the pulp so prepared into sheets and applies an insulating powder; the material is then subjected to pressure and drying heat; finally the material is treated with an insulating solution and subjected to great pressure.

Dynamos and Motors:—

Commutator Brush Holder, H. H. Blades, 459,739. Filed June 12, 1890.

Electro-Magnetic Motor, N. Tesla, 459,772. Filed April 6, 1889. Claim 1 follows: An alternating current non-synchronizing electric motor coupled with a synchronizing alternating current motor, substantially as set forth, whereby the former starts the latter and throws it into synchronism with its actuating current, and switch mechanism for directing the current through either or both of the motors.

Governor for Dynamos, M. S. Conly, 459,810. Filed Dec. 23, 1890. An electro-magnetic regulator.

Governor for Dynamos, M. S. Conly, 459,811. Filed Aug. 25, 1890. Similar to the next above.

Conductor Fastening for Commutators, S. H. Short, 459,890. Filed May 26, 1891.

Armature for Dynamo Electric Machines and Motors, J. Beattie, Jr., 459,923. Filed Dec. 9, 1890. Core has grooves in its periphery parallel to the axis of the armature, in which grooves the wire is placed; iron wire and insulating material are wound upon the outside of the armature in alternate convolutions.

Method of and Apparatus for Converting the Electrical Energy of Alternating Currents into Mechanical Motion, C. S. Bradley, 460,046. Filed Nov. 8, 1890. Consists in raising the effective counter-electromotive force developed by the rotation of the motor relatively to the self-induction of the motor by cutting the field of force rapidly relatively to the period of the supply current.

Controlling Switch for Electric Motors, S. S. Wheeler, 460,076. Filed Sept. 22, 1891. Claim 1 follows: An electric motor having its armature connected in series with its field-magnets, there being one coil for each field-magnet, in combination with a switch having four fixed terminals connected, respectively, to the ends of the two field-magnet coils, and two movable terminals located in the path of the free ends of the fixed terminals and carried by a rotary switch-handle.

Electric Regulator, J. F. McElroy, 460,059. Filed Feb 11, 1891. An electromagnetic regulator.

Electrical Transmission of Power, R. M. Hunter, 460,071. Filed Nov. 9, 1887. Claim 1 follows: The method of transmitting electric energy, consisting in generating by induction currents of low intensity and of alternately increasing and decreasing potential, then converting them by induction into currents of high intensity, transmitting the induced currents of high intensity by a line-circuit to a distant place, and then reconverting by induction said high-intensity currents back again into low-intensity currents and supplying said low-intensity currents to one or more local circuits containing translating or current-consuming devices.

Electric Motor, E. M. G. Hewett, 460,087. Filed April 2, 1891. Rotating element consists of a series of straight bar electromagnets mounted upon a common shaft, with their like poles at one end; it is enveloped by a stationary magnetic shell serving as an armature to the rotating electromagnets.

Reciprocating Tool, C. E. Lipe, 460,069. Filed Oct. 8, 1890.

Lamps and Appurtenances:—

Guard for Incandescent Lamps, H. H. Hipwell, 459,749. Filed Oct. 20, 1890

Electric Arc-Lamp, M. S. Logan & J. H. Barley, 459,757. Filed Jan. 19, 1891. The carbon rod has longitudinally diverging surfaces; feed mechanism engages with said diverging surfaces.

Manufacture of Incandescent Electric Lamps, T. A. Edison, 459,835. Filed Jan. 22, 1883. Claim 1 follows: The method of obtaining a dry nitrogen atmosphere at a definite pressure in the inclosing globe of an incandescing electric lamp, consisting in producing an air-pressure in the globe slightly above the pressure of nitrogen desired, decomposing the air left in the globe, retaining the nitrogen in the globe, removing the oxygen by putting a receptacle containing a substance having affinity for oxygen into communication with the globe, and removing the moisture from the nitrogen.

Carbon Lamps for Arc Lights, V. A. Thomas, 459,845. Filed Dec. 27, 1890.

Attachment for Electric-Arc Lamps, V. A. Thomas, 459,846. Filed Jan. 8, 1891. Consists of an insulating hood or shield adapted to be readily attached to and to enclose the lower or exposed metallic portion of a lamp.

Electric Lamp, D. Tommasi, 459,872. Filed Jan. 14, 1891. A safety lamp adapted for use in mines, powder magazines, &c.

Combination-Fittings for Gas and Electric Lights, O. Strom, 460,095. Filed Dec. 27, 1890.

Measurement:—

Electrical Recorder for Voltmeters, Thermometers, &c., C. W. Ayton, 459,868. Filed Mar. 28, 1891. A dial or gauge actuated by electromagnetic devices.

Medical and Surgical:—

Electro-Therapeutic Bath, C. P. Hoffman and W. B. Van Houten, 459,852. Filed Mar. 16, 1891.

Miscellaneous:—

Electro-Magnetic Device, G. R. Lean, 459,786. Filed April 11, 1891. For opening or restoring a circuit after a definite length of time.

Rheostat, H. E. Waite, 459,800. Filed Dec. 23, 1890.

Contact for Electric Programme-Clocks, F. E. Smith, 459,917. Filed Feb. 21. 1891.

Magnetized Hat-Band, F. H. Brown, 459,912. Filed July 15, 1891.

Automatic Electro-Pneumatic-Tube System, W. G. Collins, 460,081. Filed. Nov. 7, 1890. Includes electromagnetic devices for diverting the carrier into a branch tube.

Railways and Appliances:—

Electric-Railway-Conductor Support, E. M. Bentley, 459,737. Filed Sept. 5, 1887.

Trolley-Line Circuit-Breaker, R. M. Jones 459,753. Filed April 16, 1891.

Rheostat for Electric-Motor Cars, S. H. Short, 459,794. Filed March 17, 1891. An exposed rheostat is located outside the car body in an open flue lengthwise of the car body.

Electric Railway, R. M. Hunter, 459,815. Filed March 16, 1888. Includes a common supply conductor extending along the line of two tracks, and branch conductors connecting the supply conductor with the working conductors of the two tracks at intervals in their length.

Automatic Disconnector for Overhead Conductors, A. L. Johnston, 459,840. Filed Jan. 19, 1891.

Trolley Wheel for Electric Railways, J. A. Wetmore, 459,848. Filed Feb, 4, 1891.

Motor Mechanism for Electric Cars, S. H. Short, 460,040. Filed Nov. 1, 1890. Ring armature mounted on and directly connected with driving axle; field magnets located between the armature and the car wheel and provided with yokes mounted by journal bearings on the axle.

Telegraphs:—

Duplex Telegraphy, J. J. Ghegan, 459,930. Filed Nov. 5, 1889. Transmitting battery located at one station only.

Patent Notes.

R. M. HUNTER'S PATENT ON HIGH TENSION ELECTRIC TRANSMISSION.

THE application of alternating currents to electrical distribution has progressed sufficiently to define the main characteristics of the methods which will be employed in the future for high-tension work. Thus it may be accepted with tolerabe certainty that the high potentials will not be generated by the machines directly, but that their currents, of low tension, will be converted upwards in transformers connected to the line, and reconverted to a lower potential for local distribution at the distant end, as is now done in the Lauffen-Frankfort transmission, in the method employed for local distribution by Ferranti in London, and elsewhere.

In view of the evident importance of this method, our readers will be interested to know that a U. S. patent covering ithas been granted to Mr. Rudolph M. Hunter, the first of the seven claims of which reads as follows:

> The method of transmitting electric energy, consisting in generating by induction currents of low intensity and of alternately increasing and decreasing potential, then converting them by induction into currents of high intensity, transmitting the induced currents of high intensity by a line-circuit to a distant place, and then reconverting by induction said high-intensity currents and supplying said low-intensity currents to one or more local circuits containing translating or current-consuming devices.

The patent is entitled Electrical Transmission of Power; No. 460,071, issued Sept. 24, 1891; original application filed Nov. 9, 1887. The patent is assigned to the Thomson-Houston Electric Company.

MR. C. R. FISH has severed his connection with the Woburn Electric Light Co., of Woburn, Mass., and has removed to Cambridge, Mass., where he assumes a position with another electric concern.

Legal Notes.

A NEW INCANDESCENT LAMP SUIT.—THE CONSOLIDATED ELECTRIC LIGHT CO. v. THE N. Y. LIFE INSURANCE CO.

THE Consolidated Electric Light Company, which is operated under lease by the Westinghouse Company, brought suit in the United States Circuit Court, on September 24, against the New York Life Insurance Company, of this city, alleging infringement of the Sawyer-Man patent for incandescent lamp carbons. The lamps in question were furnished by the Brush-Swan Company, and it is understood that this company will assume the defence of the suit. This is the same patent on which suit was brought against the McKeesport Electric Light Company, and defended by the Edison Company, and which was decided by Justice Bradley at Pittsburgh in 1888 adversely to the patent.

Reports of Companies.

WESTERN UNION TELEGRAPH CO.

THE Western Union Directors at their quarterly meeting declared a regular dividend of 1¼ per cent. The report for the quarter showed an estimated surplus of $680,207, with a total surplus of $12,097,948.

DIVIDENDS.

THE SOUTHERN MASSACHUSETTS TELEPHONE CO. has declared a semi-annual dividend of $2 a share.

THE WARE, MASSACHUSETTS, ELECTRIC LIGHT CO. has declared a semi-annual dividend of three per cent. on $20,000 stock.

THE EDISON GENERAL ELECTRIC CO. has declared its eighth quarterly dividend of two per cent.

Obituary.

CLARENCE E. LOOMIS.

WE regret to record the death of Mr. Clarence E. Loomis, a promising young mechanical and electrical engineer, who, after his graduation from Cornell in 1888, became connected with the Mather Electric Co. and the Thomson Electric Welding Co. About a year ago he went to Denver for the benefit of his health and to take charge of work on the West End Electric Railroad in that city. His death there is a grief to many friends all over the country.

CORRECTIONS IN MR. LEONARD'S ARTICLE.

WE beg to call the attention of our readers to two typographical errors which inadvertently crept into Mr. H. Ward Leonard's article appearing in our issue of Sept. 2, 1891.

In formula (7) the denominator of the second term should read 750 $V(E-V)$, instead of 750 $E(E-V)$.

Formula (18) should read as follows:

$$\frac{I}{100}\left(\frac{G\,E}{E-V}+\frac{D^2L}{750\,V(E-V)}\right)$$

THE RIGHT TO MANUFACTURE THE PORTER MOTOR.

WE are in receipt of the following letter from the Porter & Leavitt Electric Motor Co., of Providence, R. I., under date of Sept. 4, 1891.

"We understand that certain parties are manufacturing and offering for sale our electric motor under the name of 'Porter Standard Motor' without our license or consent. Mr. Harry H. Porter is the inventor and sole patentee of the Porter motor, and has granted to our firm, of which he is a member, the sole and exclusive right to manufacture and sell the same, and all persons are warned against using or selling the motor without authority from us, and we have instructed our counsel to commence proceedings to restrain the parties mentioned from making or selling the motor, and to recover damages against them for infringement of our patent.

"We will be obliged to you if you will insert this letter in THE ELECTRICAL ENGINEER, in order that the trade generally may have such knowledge as will enable them to avoid handling infringements of our patent, which will render them liable to pay damages."

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Advertising is a great fertilizer in the business field.

THE RIES REGULATING SOCKET.

The Ries Regulating Socket.

THE accompanying illustration shows a novel socket for incandescent lamps on alternating circuits, by means of which the light may be turned up or down as readily as a gas jet, the current consumed being proportional to the brilliancy of the light. This was well demonstrated at the electrical exhibition held in connection with the Montreal Convention, where a lamp fitted with a Ries socket was shown with a small ammeter in circuit.

This device thus saves a large amount of current when the lamp is not required to be up to candle-power, and, it is claimed, saves the filament, as the current cannot be switched on suddenly, but has to pass all the gradations of the socket. The Ries Electric Specialty Co., of Baltimore, manufacture two sizes of this socket, one for lamps of from 16 to 25 c. p. and the other for those of from 32 to 50. There is no resistance used in the device, but the working of the socket depends upon a small choking coil.

EUREKA TEMPERED COPPER CO.

IT was a natural and proper thing that the Eureka Tempered Copper Co., of North East Pa., who, through the ingenuity of a Yankee, discovered the art of refining and tempering copper, should be awarded by the Committe on Science and Arts of the Franklin Institute the John Scott medal and premium by reason of this discovery. Their goods are now in universal demand for electrical purposes. The conductivity of the metal is increased by the tempering process. The castings are dense and free from pin holes, which has been deemed impossible with pure copper.

The company has increased its facilities for turning out goods promptly, their foundry room being 200 feet long and 50 feet wide, with twelve furnaces. The finishing departments are equipped with standard tools, and these departments filled with skilled workmen. The merits of their goods are attested by users in many high encomiums, the life being double under actual wear, and in some cases four fold.

REPORTS AND BIDS WANTED FOR SAN SALVADOR.

THE Compania de Alumbrado, of San Salvador, Central America, wishes to receive catalogues and price lists from electric lighting, electrical supply, wire companies, etc., addressed to their director, Mr. M. Cohn, who is about to call for proposals on another electric light plant. Mr. L. P. Pennypacker, C. E., is the chief engineer of the company.

THE CHAS. MUNSON BELTING CO.

WE are glad to publish the following received from the Munson Co.:

"Since the death of Charles Munson, the founder of this establishment, it has come to our notice that some of our competitors have set afloat certain false rumors that this company was going out of business. Although none of our friends placed any credence in these rumors, we deem it our duty to pronounce all such and similar rumors and statements concerning the future of this company utterly untrue and false. At the same time, we desire to inform our customers that this company will continue to exist and manufacture the same high grade of belting for which we have earned such a well-merited reputation in the past.

"THE CHARLES MUNSON BELTING CO.,

"E. A. GROETZINGER, Sec."

THE NEW "DICK & CHURCH" TANDEM COMPOUND ENGINE.

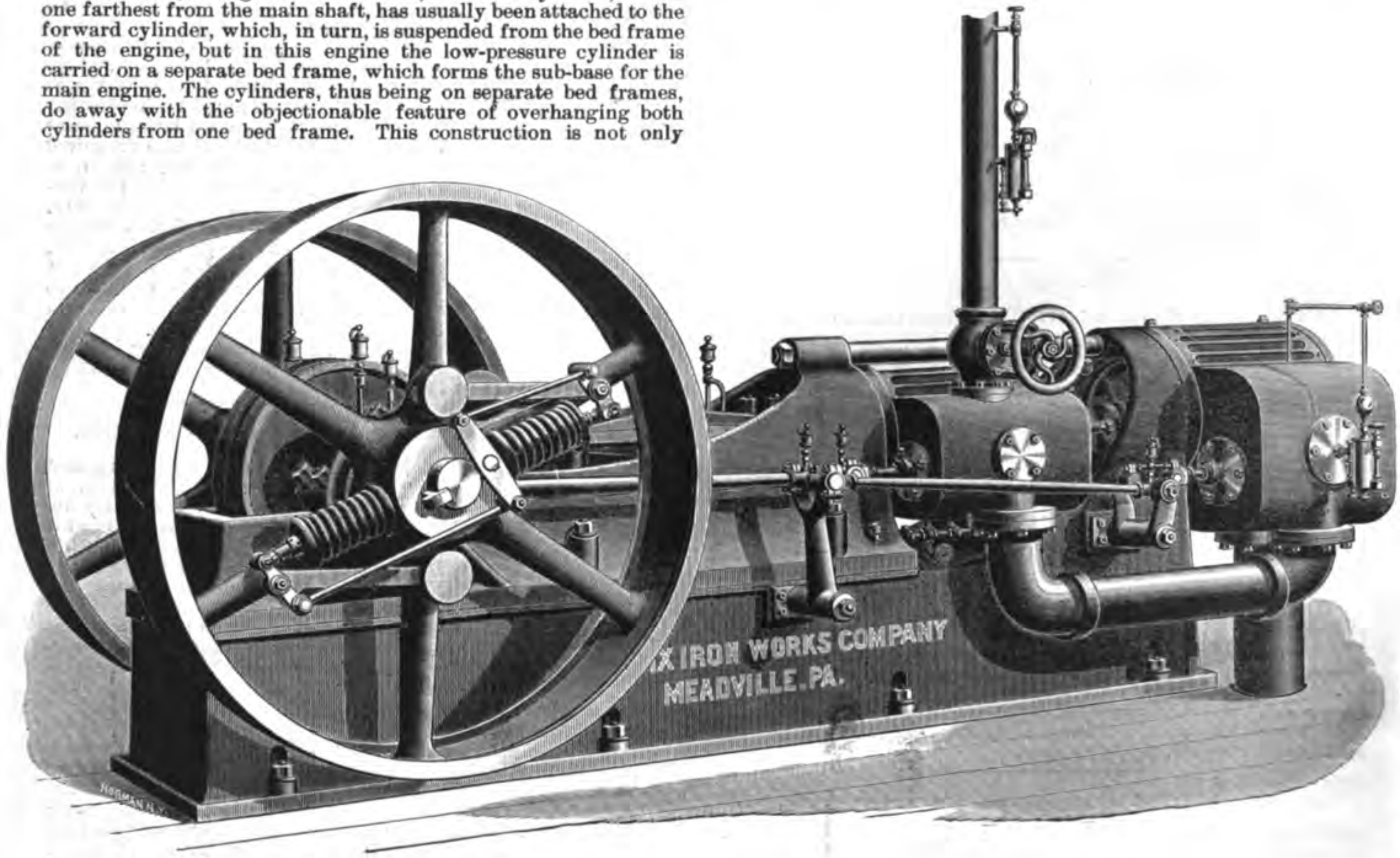
THE history of the modern development of electricity is that of the high-speed automatic cut-off engine, the latter having kept pace with the demands and improvements of the former. In the earlier stages of this development the question of economy was not so carefully considered as now, and, furthermore, it has not been considered that the single-valve type of engine could show such results as would justify its use except in small plants. The later developments have shown that this is not the case, and the peculiar adaptability of the high-speed engine for electrical purposes is now generally conceded. An excellent example of this type is the new "Dick & Church" tandem compound engine shown in the accompanying illustration, and as it embodies many new and valuable features, a description cannot fail to interest our readers.

Heretofore, in engines of this class, the rear cylinder, or the one farthest from the main shaft, has usually been attached to the forward cylinder, which, in turn, is suspended from the bed frame of the engine, but in this engine the low-pressure cylinder is carried on a separate bed frame, which forms the sub-base for the main engine. The cylinders, thus being on separate bed frames, do away with the objectionable feature of overhanging both cylinders from one bed frame. This construction is not only rigid, but allows each cylinder to expand independently of the other, always preserving the alignment; it also renders either cylinder easy of access without disturbing the other. The hoods which carry the overhanging cylinders are rigidly tied together by a rod which extends from one to the other, over the top of the high-pressure cylinder.

The valve gear is so constructed that the valves of both cylinders are controlled automatically by one governor; a new and valuable feature in engines of this class, and which gives practically a regular receiver pressure and proper distribution of load and temperatures between the two cylinders at all points of cut-off.

Special pains have been taken in designing this engine to have ample wearing surfaces, and to make the proportions such as to meet the requirements of extreme and varying loads, such as are met with in electric railway service. The oiling devices are thorough and ingenious, and particular care has been taken to prevent the throwing or waste of oil. The manufacturers have also lately brought out a centrifugal oiling device for the governor, which ensures the most perfect lubrication of all the working parts; in fact, every bearing on the engine can be thoroughly lubricated while the engine is in motion.

A test was lately made at Jamestown, N. Y., on one of these engines which gave most favorable results, considering the particular conditions under which the test was made. The engine is nominally rated at 150 h. p., but the greatest average load obtainable, at the time of the test, was less than 105 h. p. The engine, working under these conditions, developed a horse-power on 17½ lbs. of steam per horse-power per hour, and on an actual coal consumption of 2 lbs. per horse-power per hour, or 1.89 lbs. of combustible. The diameter of high-pressure cylinder was 11 inches; that of the low-pressure cylinder, 20 inches; stroke of both cylinders, 15 inches; revolutions per minute, 240, which gave a piston speed of 600 feet per minute. The boiler pressure carried during the test was 108 pounds. The coal used was an inferior grade of bituminous slack and nut mixed. The engine was charged with the entire cost of driving the condenser and boiler feed pump, and while the conditions of the load, etc., were very unfavorable for both the engine and the boiler, the results obtained were very gratifying to the manufacturers, and go to show that, with a proper load, the very highest duty may be expected. The test referred to was made by well-known experts. It is hoped to have a test made soon under conditions which will properly demonstrate what this engine is capable of doing.



NEW "DICK & CHURCH" TANDEM COMPOUND ENGINE.

The manufacturers have lately placed several of these engines, both of the condensing and non-condensing type, in electric street railway and lighting plants, and all are giving the very best results. In some cases duplicate orders have already been received. The well-known Phœnix Iron Works Company, of Meadville, Pa., are the builders of this engine. They have also branch offices at 15 Cortlandt street, New York, and 418 Chamber of Commerce Building, Chicago.

GREAT WESTERN ELECTRIC SUPPLY COMPANY.

THIS company, sole agents for the Sun arc lamp, are receiving many orders for their lamp. The sale is increasing wonderfully. This lamp is especially adapted for use in theatres, central stations, halls, stores, or in fact, any place where the ordinary arc lamp is undesirable. It gives a steady, clear, bright light, and for direct current incandescent circuits it is claimed to have no equal.

The Great Western Electric Supply Company, are also agents for the celebrated K. K. wire. A large amount of this was sold last month, and indications thus far this month point to even a larger sale than ever.

They have just issued a railway catalogue, one of the most elegant of its kind ever issued, and are also issuing two new catalogues of the house-goods department and the lighting department.

THE NEW FACTORY OF THE BERLIN IRON BRIDGE CO.

In enlarging their facilities to meet the demand that has arisen for their admirable products, the Berlin Iron Bridge Co. has had an excellent opportunity at its new factory, East Berlin, Conn., to illustrate and exemplify the principles. it has been preaching for factories and central stations. In fact, this new factory is built on the same lines as the Washington Electric Light Co.'s station, the Pawtucket Gas and Electric Light Co.'s plant, and others.

Owing to the limited amount of land available the company decided to build their new plant on the east side of the Mattabesset River, in the town of Cromwell, connected with the old plant by an iron bridge of sufficient capacity to not only carry the narrow-gauge cars which move their material about the premises, but also to carry an ordinary standard-gauge locomotive and loaded cars. The general plan of the company's new plant as now arranged comprises about three acres of land located along the line of the N. Y., N. H. & H. R. R. The main building is 400 feet long by 80 feet wide, constructed entirely of brick, iron and glass. The general features of the construction are shown in the interior view taken from a photograph.

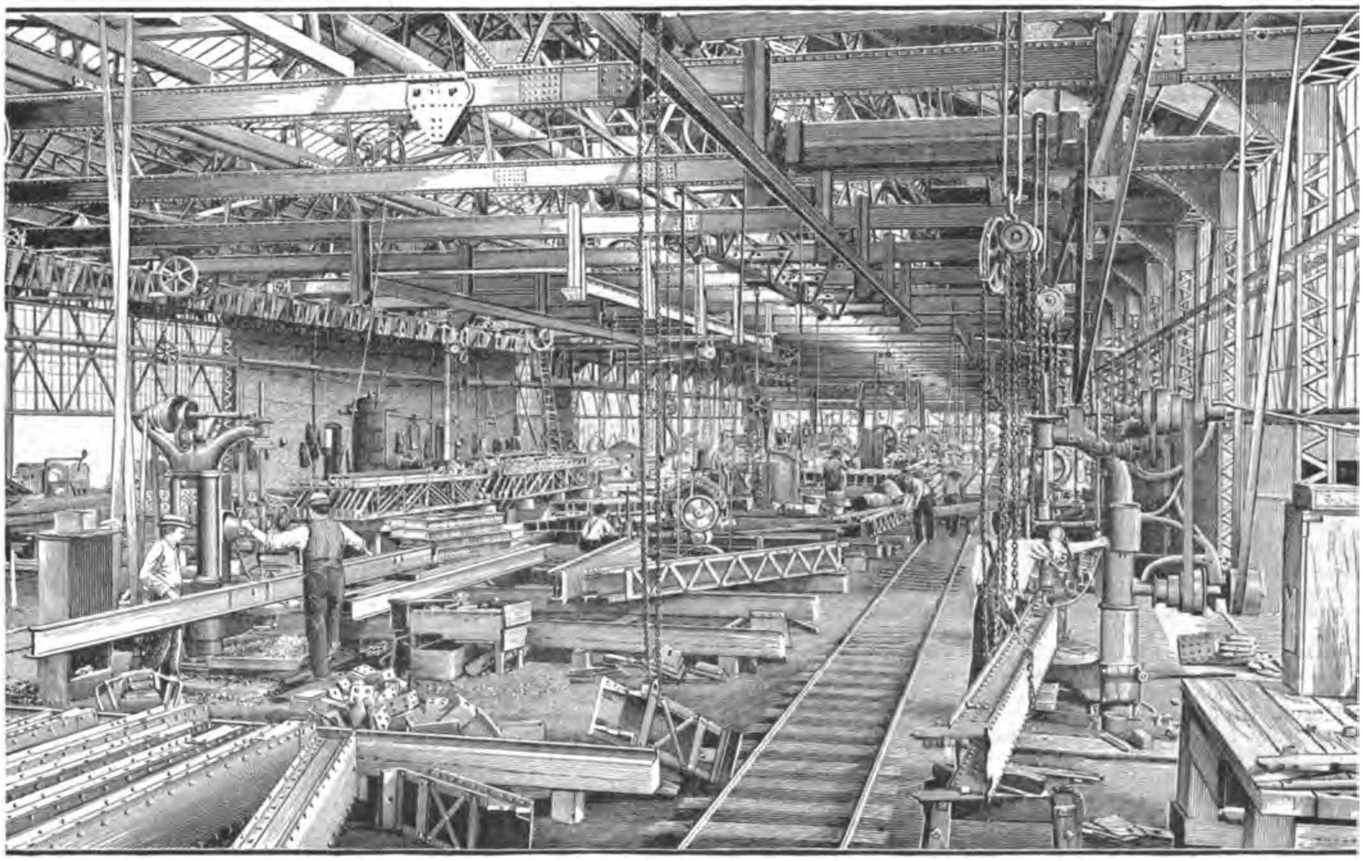
The sides of the building are made of glass for a distance of 10 feet from the eaves and below that are constructed of iron sliding-doors, so arranged that they can be opened and closed quickly in order to allow the material to enter through the sides of the building, when necessary, and in summer they can be removed entirely, thus very materially adding to the comfort of the employees. The roof trusses are of iron, each truss designed to carry 10,000 pounds at any point along the line of the lower chord.

The whole plant is connected together by standard-gauge tracks in such a way as to admit of the economical discharge of the raw material and the quick and economical loading of the finished product. The standard-gauge tracks extend the whole length of the plant on each side, and at the front of the building, from which the finished product is discharged, there are other spur tracks of standard gauge, one of which enters the building for a distance of 120 feet, so as to admit of iron being loaded inside of the building during wet weather.

All the tracks are controlled at the front of the building by two jib cranes so arranged as to work from a four-drum Mundy hoisting engine, so that one man can operate both cranes at the same time. The loading facilities are of such a nature that 10 cars can be loaded in an ordinary day of 10 hours.

The building itself is served by three lines of narrow-gauge tracks, one on each side and one through the centre, the tracks being connected at each end of the building by transfer-tables, the transfer-tables also connecting these tracks with the tracks in the yard. The raw material is distributed on each side of the main building direct from the cars, and after being sorted is moved by means of the narrow-gauge tracks into the north end of the building—the end shown on the left of the above illustration—where it is laid out from templates, trimmed at the shears and prepared for the punches.

The punches are all arranged with a "drop motion," so that the punch can drop down on the work, and thus the operator is able to find the centre mark and punch the hole exactly in the proper place. From the punches the material goes to the riveting machines, and from the riveters to the planers, drills, etc., and out at the south end of the shop, so that under no circumstances is there any occasion for work to pass except in one direction through the shop, the raw material coming in at one end and the finished product passing out at the other.



The New Factory of the Berlin Iron Bridge Co., East Berlin, Conn.

The building is heated by the well-known Sturtevant system of hot air, and all furnaces both under the boilers and for rivet heating are equipped with fuel air-burners so that crude petroleum is used entirely for fuel through the whole plant, although the boilers are so arranged that coal can be used if desired.

The plant is lighted by a neat Thomson-Houston plant of 500 incandescent lamps run from two machines.

The whole plant is constructed of iron with no wood-work about it, so that there is absolutely no risk from fire, and the company are not obliged to carry any insurance, as there is nothing about the building which can in any way take fire and burn. The construction being of iron, the cost of maintenance consisting only of painting, so that here we have a plant which seems to combine all the requisites of improved shop practice, as certainly with the improved facilities a shop of this kind ought to handle all classes of structural work with the least possible outlay for labor.

In a construction of this kind the cost of maintenance, repairs, insurance, and that class of expenses is reduced to an absolute minimum.

NEW YORK NOTES.

CHAS. A. SCHIEREN & Co. have recently taken an order from the Davenport Gas Co. for about 110 feet of 48-inch double belt, and necessary dynamo belts. They have also received an order from the South Bend Electric Co., South Bend, Ind., for about 110 feet of 48-inch double belt, 100 feet of 20-inch double belt, and all the necessary dynamo belts. They are now introducing their "Electric Leather Belt Stuffing," which closes the pores of the leather, and prevents further stretching.

MR. SIGMUND BERGMANN, the well-known electrical manufacturer, has just returned from a prolonged vacation in Europe, during which he has seen all that there is worth seeing in the newer electrical developments.

J. JONES & SON, of 602 and 604 West 22d street, New York, are very busy on a large order for time stamps.

MR. P. CLAUS has made arrangements with the Germania Electric Company, 53 State street, Boston, to build again the well-known "Continental" dynamo.

NEW ENGLAND NOTES.

THE ELECTRIC GAS LIGHTING COMPANY, of Boston, have made a decided hit with their new style of annunciator, called the "Hub" needle annunciator, designed more especially for the Southern and Western trade. This instrument is designed to take the place of their well-known "Tirrell" gravity drop annunciator; is a thoroughly reliable instrument, and is a first-class device of its kind, and is at the same time of extremely low cost. The drops are all mounted on a metal base, which cannot warp or shrink to throw the mechanism out of adjustment. The Porter motor is also forming a good attraction for their fall trade, and is evidently just what was wanted, being a low-price practical motor. The Samson battery is always a strong "stand-by," and this fall the sales have been something unprecedented. A large cargo of Samson carbons, direct from Paris, is at present only a few miles away from Boston harbor, and if the present high tides hold for a few days more, the ship may be expected to cross the bar safely, notwithstanding its heavy load. The Samson jar has been changed somewhat lately, for the sake of general convenience, the corners of the jar being more rounded and the carbons supported from the top of the jar, so that the carbons do not touch the bottom. This change, however, does not affect the perfect interchange of parts of the old style with the new.

THE EASTERN ELECTRICAL SUPPLY AND CONSTRUCTION COMPANY, of Boston, have recently been reorganized with a new board of directors. The new board is now composed of the following gentlemen: M. W. Brown, president; W. B. Ferguson, vice-president; A. Otis Smith, secretary and treasurer; and L. A. Dean and D. J. Hern. Mr. Ferguson, one of the new members, has for years been identified with electrical interests, and lately has become quite prominent in electrical railway circles. Mr. Hern, the other new member has been for years superintendent of the Mutual Union Telegraph, and is now general manager of the Mutual Union district messenger service. The capital of the company has been increased to $250,000. The business of the company is increasing every day, and they are now amongst the foremost of the electric supply houses in the East. They carry a very complete line of supplies for electric railway work, having made from the start a specialty of this branch of work.

ALBERT & J. M. ANDERSON, of Boston, have recently received orders for large numbers of their bell insulators made out of their new insulating material called "Ætna." They have also supplied the Buffalo Street Railway Company with about 5,000 pieces, and have done a large amount of work for the Brooklyn Street Railway Company. Ætna has been put to several severe tests, among which may be cited a crucial test, consisting of boiling a number of Ætna insulators in water for several hours. When cooled off the material was found to be just as good and as perfect in shape as before the test. The Messrs. Anderson are building at present some very handsome large switchboards of slate and marble, which are well worth seeing, their reputation for this class of work being very high both for electrical and mechanical excellence.

BEATEY & HODGSON, of 209 Washington street, Boston, who commenced a general electrical engineering business this summer, have met with exceedingly good success up to the present. During the summer months they have done a considerable amount of central station work. Mr. Beatey's long connection with the electrical business and thorough knowledge of electrical work make this firm much sought after for good advice and sound construction.

THE RUSSELL ELECTRIC COMPANY, of Boston, at their annual meeting last week in Portland, Me., elected the following gentlemen as directors for the ensuing year: A. W. Rounds, H. E. Chapman, A. N. Reynolds, H. W. Boyd, O. A. Willard, W. F. Robbins, F. H. Carpenter.

THE SAMSON CORDAGE WORKS, of Boston, have recently issued a neat little pamphlet relating to their special cords for hanging arc lamps, bell-cord couplings, trolley cords and various cords for other electrical purposes. This cord is specially waterproof and is well adapted for electrical work, and is well worthy of close investigation by all users of cord.

THE PROVIDENCE CONSTRUCTION COMPANY, of Providence, R. I., of which Mr. H. G. Wright is superintendent, has recently installed 170 Ball arc lights in the Palmer Mills, Three Rivers, Mass., and about 70 Ball arc lights in the Loraine Mills, Woodlawn, R. I.

WESTERN NOTES.

THE ELECTRIC MERCHANDISE COMPANY, Chicago, report for the last week the closing of contracts for the complete equipment of electric roads at Defiance, Ohio, and Negaunee and Ishpeming, Mich. The superiority of the equipment manufactured by this old and reliable company is recognized by both parent electric companies and construction companies, as well as practical street railway managers. They also report during the same period, orders for the Burton electric heater from roads in Amsterdam, N. Y.; Lake Superior, Wis.; Milwaukee, Wis.; Escanaba, Mich.; Defiance, Ohio; Dallas, Texas; Newton, Mass.; Champaign, Ill.; Helena, Mon. and Ann Harbor, Mich.

THE CENTRAL ELECTRIC COMPANY have just completed arrangements for the exclusive handling of the Gladiator Dry Battery. This arrangement was arrived at only after the most exhaustive tests of the Gladiator, and the Central people are confident that they have the very best dry battery now on the market. A series of curve cards showing the characteristics of this battery will shortly appear in these columns.

MR. W. H. APPELGATE 260 S. Clark street, Chicago, has invented a novel form of underground conduit for electric street railways which possesses some important improvements over the ordinary forms. The problem of high insulation, under all conditions, and hence the obviating of leakage, has been worked out in a very thorough and successful manner. The main current is carried in an insulated cable, connection to which is made by the car automatically at certain points by a positive mechanical action. Neither sectional conductors nor electromagnets are employed in this system, and it is exceedingly cheap to install, and can be conveniently put in existing cable conduits. Mr. Appelgate is showing a working model at the Exposition Building.

MR. CHAS. G. ARMSTRONG the electrical expert of the Auditorium Tower, has drawn up the specifications for the plant to be put into the Central Indiana Hospital for the Insane. They cover both the arc and incandescent lights and the needed steam outlet, the whole making a good-sized isolated plant. The bids are to be closed Oct. 9th, and the work will be pushed during the following month. Mr. Armstrong will probably have a chance to introduce a number of his novel devices in connection with this plant.

MR. LUTHER STIERINGER, the well-known authority on electrical illuminations in exhibitions, is in Chicago consulting with the exhibition authorities and with Mr. Frederick Sargent, the electrical engineer of the construction department. Mr. Stieringer is one of the advising committee of electricians specially appointed by the committee on illumination; Prof. F. B. Badt and Mr. Paul Lemaire being the other members.

THE CHAS. MUNSON BELTING CO. are furnishing a goodly number of belts for electric railways and lighting plants. The very large belt, recently noticed in our columns, manufactured by this concern for street railway work in St. Louis, is completed and ready to be placed on the pulleys.

THE SUNBEAM INCANDESCENT LAMP CO. are running their factory day and night and even then find it hard work to keep pace with their orders. The Sunbeam lamp has an enviable reputation for long life with full candle-power, with a constant and small absorption of current.

MR. WILLIAM HOOD, 239 La Salle street, is having a brisk run with the Jewel incandescent lamps, which are giving eminent satisfaction in the numerous plants using them. Mr. Hood is also selling quite a number of storage-battery outfits for various work.

MR. GEORGE CUTTER, 333 The Rookery, is selling a large number of his magnetic cut-outs. They are manufactured in various sizes and different styles for railway motors and stationary motors, and with lightning-arrester attachment.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE

Electrical Engineer.

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REMINISCENCES OF JOHN H. B. LATROBE.

BY

Franklin Leonard Pope

John H. B. Latrobe.

JOHN H. B. LATROBE, lawyer, scholar, historian, engineer and inventor, died at his home in Baltimore on September 11, aged 89 years. His father, an eminent architect, was the original designer of the Capitol at Washington; his mother's family were closely related to the distinguished astronomer Rittenhouse. Mr. Latrobe was the legal and technical counselor of the elder Winans during the work of building and organizing the Baltimore and Ohio railroad, the earliest trunk line from the Atlantic States to the Ohio Valley. When Morse finally reached the point of the realization of his hopes of a commercial electric telegraph, and the Congressional appropriation of $30,000 had been placed at his disposal, his difficulties were, in fact, but scarcely begun. The then president of the Baltimore & Ohio, the only railway line entering the capital, was the Hon. Louis McLane, a man of wide experience, and one of the foremost statesmen of his day. To him Morse appealed for the grant of a right of way for the construction of his experimental line from Washington to Baltimore. The proposed undertaking, so utterly without precedent, and so seemingly chimerical, perplexed the worthy president not a little. Aware of the incomparable aptitude of Latrobe in every emergency, McLane finally referred the troublesome matter to him. "While President McLane and myself were yet speaking of the matter"—once said Mr. Latrobe—"Mr. Morse made his appearance, and when Mr. McLane introduced me, he referred to the fact that, as I had been educated at West Point, I might perhaps the more readily understand the scientific bearings of the invention. The president's office being no place for a prolonged conversation, it was agreed that Mr. Morse should take tea at my home, when we would go over the whole subject. We met accordingly, and it was late in the night before we parted. Mr. Morse went over the history of his invention in detail, from the beginning, with an interest and enthusiasm that had survived the wearying toil of an application to Congress, and with the aid of diagrams, drawn on the instant, made me master of the matter, and wrote for me the telegraphic alphabet which is still in use over the world. Not a small part of what Mr. Morse said on this occasion had reference to the future of his invention—its influence upon communities and individuals—and I remember regarding, as the wild speculation of an active imagination, what he prophesied in this connection, and which I have lived to see more than realized. Of course my first visit next morning was to Mr. McLane to make my report. By this time I had become as enthusiastic almost as Morse himself, and repeating what had passed between us, I soon saw that Mr. McLane was becoming as eager for the construction of the telegraph to Washington as even Mr. Morse could have desired. He entered warmly into the spirit of the thing, and laughed heartily, if not incredulously, when I said to him that, although he had occupied exalted positions as the representative of his country abroad, and of his party at home, his name would be forgotten, while that of Morse would never cease to be remembered with gratitude and praise."

Accordingly at the next monthly meeting of the directors of the road, on April 5, 1843, the formal application of Professor Morse for the privilege of laying his conductors was presented, accompanied with a communication from Chief Engineer B. H. Latrobe, strongly recommending the project as one worthy of every encouragement. After a protracted discussion the following cautiously worded resolution was passed by the board by a nearly unanimous vote:

Resolved, That the President be authorized to afford to Mr. Morse such facilities as may be requisite to give his invention a proper trial upon the Washington road; provided, in his opinion and that of the engineer, it can be done without injury to the road, and without embarrassment to the operations of the company, and provided Mr. Morse will concede to the company the use of the telegraph upon the road without expense, and reserving the right of discontinuing the use, if upon experiment, it should prove in any manner injurious."

Until quite recently Mr. Latrobe, notwithstanding his advanced age, remained in full possession of his faculties, and had acted as counsel in many of the most important patent causes within the past few years, notably those in which the Baltimore & Ohio company were in any way interested. He also bore a prominent part in the litigation over Edison's quadruplex patents, some years since. He was a man of noble and striking personal presence, and of extraordinary and varied ability in many directions. The commercial success of the electric telegraph in the United States has certainly been indebted in no small measure to his early, intelligent and persistent championship of its cause at a critical period in its history.

EARTH CURRENTS IN NEW YORK CITY.

BY

E. W. Stevenson.

THE phenomenon of earth currents in submarine or subterranean cable is explained by all electrical authorities as being the result of different potentials of the earth at different places along the line. Barometric pressure and temperature also have something to do with it; thus the longer the line, the greater the climatic difference of conditions, with a consequent increase in intensity of earth currents.

These currents may be electro-positive or electro-negative. They may be (1) constant, either positive or negative; or (2) they may vary in intensity, either positive or negative; or (3) again they may vary in quick succession from electro-positive to electro-negative, that is to say, not regularly, but spasmodically. Thus, in taking readings on a Thomson reflecting galvanometer, such as is used by electricians in testing high resistances, the deflection, case (1), may remain steadily at 150 divisions +, or 150 —; or again in case (2), it may make a series of jumps from zero to + 10, + 50, + 60, + 100; then fall away again thus, + 30, + 25; then rise to + 40; then perhaps drop to + 5, and so on.

Similarly the currents may have like action on the other side of zero; making all the readings electro-negative. In case (3) where the currents change from electro-positive to electro-negative, I have seen the spot rush rapidly from side to side, producing readings something like this: 10 + to 50 —; 60 + to 20 —; 200 + to 320 —; 10 + to 400 —; 650 + to 45 —; varying sometimes so rapidly that it defies all but the most experienced eye to catch anything like a reading.

With submarine telegraph cables, I have known instances when all communication has been interrupted, and on several occasions, while I was assistant electrician on certain Atlantic cables, I have had to report that I could get no test on account of the intensity of the earth currents.

With reference to earth currents in a city like New York, the reason for their existence of course could not be ascribed to climatic differences of condition of different parts of the line; as, although a circuit may be 20 miles long or more, the area in which such a circuit lies would be so small as to be unaffected by such differences; therefore some other cause must be looked for. It is a fact, although not generally known, that on account of the enormous amount of current generated for electric light, power, etc., for use in the city, the leakage is proportionately large; for instance, if one side of an incandescent circuit is attached to a lamp, and the other side of the lamp grounded, enough current can be obtained to light the lamp. Any one using a telephone with an earth return can hear the peculiar humming noise with short, sharp snaps occasionally. This noise is generally put down to induction, and probably part of it is due to that cause; but a good deal is due to earth currents. Now it can be readily seen what effect these currents would have upon the delicate mirror of a Thomson galvanometer, and from the varying potential of currents in different parts of the city, owing to more or less leakage, would be obtained an effect similar to the difference of barometric conditions mentioned before.

To illustrate the accuracy of this statement, a cable company had to lay a highly insulated wire as an earth return from their office to the cable hut, and there soldered on to the sheathing of the cable running into the sea, so as to eliminate the disturbance due to earth currents in New York city. Since electric cars have been running parallel to the line, the operators in the office have had a good deal of bother with the signals on the recorder, and these were found to be simultaneous with the stopping and starting of the cars.

With reference to earth currents on electric light cables in this city, circuits running from the 29th street station of the United Electric Light and Power Company always contain more than circuits running from any other of this company's stations, and when testing from one end only, the maximum deflection is obtained. By taking both ends, however, it is considerably lessened (Herbert Taylor's method), generally about one quarter. The reason for these excessive currents is probably due to the majority of these circuits running together very closely for ¾ mile.

A peculiarity I have noticed at the Brush station, in Elizabeth street, is that, whereas circuits running down Elizabeth street produce electro-positive currents, circuits running around Prince, and down the Bowery, produce electro-negative currents, readings being more erratic on Elizabeth street.

Authorities on cable-testing briefly mention the subject of earth currents, and dismiss it by stating the cause, but information is very meagre on methods of dealing with it when it occurs in actual testing on submerged or underground cables. Culley has a chapter on the causes, but nothing about illumination. Kempe briefly states that Mr. Herbert Taylor does away with it by taking both ends of the cable to the terminal pole, as before mentioned. This method Mr. Taylor introduced at the testing-room of the Telegraph Construction and Maintenance Company, of London, where the writer was at one time engaged, and dealt only with cables coiled up in tanks, and again he was testing with cables measuring about 1,200 megohms per mile. Munro and Jamieson's small pocket-book has a short paragraph on page 147, Note 3, latter part, which says: "It is usual to add to or subtract from deflections, these earth readings according as they may be against, or with, the battery current." Preece and Sivewright advise taking the positive deflection x, then take the negative y; the reading will be $\frac{x+y}{2}$; that is the mean of the two. This might fail to give an accurate result in the case of an inferior core, as some of these produce a current of themselves which is due neither to earth current nor induction, but from an electrolytic action between the conductor and whatever is used as a ground; in fact, constituting a regular battery combination.

The method I have always used has been to note the earth current before testing, and in the case of testing from a central station, I have frequently got some one to put down the readings as I called them out, when the currents were very erratic, such as + 50, — 10, + 40, + 60, + 90, — 120, — 130, — 5, 0, + 6. Occasionally these will be very rapid and jerky, as I noted in case (3) above; then I add up all the positives, subtract the sum of the negatives and divide the result by the number of readings taken. This result may be negative or positive according to which predominates. In the same way I take my reading when the positive pole of the battery is applied to the cable under test, and again with the opposite pole of the battery to cable, make my additions or subtractions as the case may be. For instance, by taking the earth currents quoted above, the result = — 1.9 divisions, which is nearly zero. By this method I find that my + readings and — readings generally come out about equal. Of course, sometimes an earth current may give + 250 or + 2,500, although the latter case is generally when testing with lamps in circuit, and the insulation is about down to two or three megohms total, giving earth currents the best possible chance of getting in. In these cases, should the reading be + it is subtracted from the + reading of the leakage on the cable, and added to the — reading. Should the currents be —, the reverse is then done. If one has not had much experience on subway wires, all these disturbances might make him suspect that the cable was faulty, but I have known short lengths of even a mile testing up to 600 or 700 megohms show very erratic earth currents; and again I have had cable very poorly insulated show no disturbance at all.

In testing with lamps or converters in circuit, there is always a great deal of leakage, and if an incandescent and an arc circuit run into the same building, sometimes through the same pipe, the converters and cut-out box may be near each other, and the very slightest trace of moisture, although the resistance may be 1,000 megohms, will tend to have considerable effect on the instrument. Multiply this effect 50 times, as is the case with 50 converters in circuit, and that effect will assume a like increase, especially when one takes into consideration the number of times a circuit runs parallel with many others, and the number of times it crosses and recrosses many more.

In conclusion, I do not attempt to prove that excessive earth currents do not show a fault in the cable, but I will maintain that such an effect does not indicate that the cable is faulty.

ELECTRIC MINING IN SOUTH AFRICA.

A PROPOSAL has been made to use electric transmission of power at the Eureka Mine of the Victory Hill Consolidated Mining Company, South Africa. Both mine and mill would be furnished with all the light and power necessary for working. It is proposed to lay down a 100 h. p. plant, 60 h. p. of which would be delivered at the power station at the mine. The power would be obtained from turbines placed near the junction of the Golden Valley stream with the Kaap River. Water enough for the plates of a 25-stamp mill would be available.

THE LOCALIZATION AND REMEDY OF TROUBLES IN DYNAMOS OR MOTORS.—IV.

BY

Francis B. Crocker and S. S. Wheeler.

HEATING OF BEARINGS.

1. Cause.—*Lack of oil.*

Symptom.—Shaft and bearing look dry. Shaft usually turns stiffly. Oil cup or reservoir empty.

REMEDY.—Supply oil, and also make sure that oil passages as well as feeding or self-oiling devices work freely, and that the oil cannot leak out. This last fault sometimes causes oil to fail sooner than attendant expects.

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2. Cause.—*Grit or other foreign matter in bearings.*

Symptom.—Best detected by removing shaft or bearing and examining both. Any grit can of course easily be felt, and will also scratch the shaft.

FIG. 5.—SHAFT ROUGH OR CUT.

REMEDY.—Remove shaft or bearing, clean both very carefully and see that no grit can get in. Place motor in dustless place or box it in.

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3. Cause.—*Shaft rough or cut.* (Fig. 5.)

Symptom.—Shaft will show grooves or roughness, and will probably revolve stiffly.

REMEDY.—Turn shaft in lathe or smoothe with fine file and see that bearing is smooth.

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4. Cause.—*Shaft and bearing fit too tight.*

Symptom.—Shaft hard to revolve by hand.

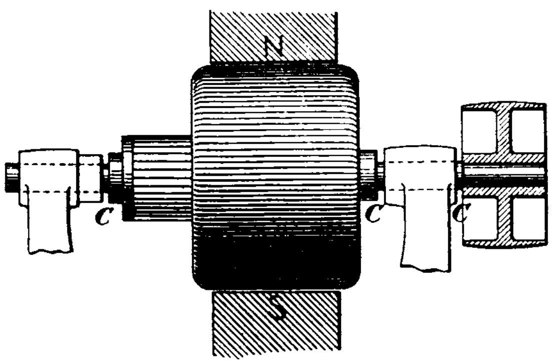

FIG. 6.—ARMATURE WITH GOOD CLEARANCE AT C C.

REMEDY.—Turn or file down shaft in lathe, or scrape or ream out bearings.

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5. Cause.—*Shaft "sprung" or bent.*

Symptom.—Shaft hard to revolve and usually sticks much more in one part of revolution than in another.

REMEDY.—It is almost impossible to straighten a bent shaft. It might be turned true but probably a new shaft will be necessary.

6. Cause.—*Bearings out of line.*

Symptom.—Shaft hard to revolve, but is much relieved by loosening screws which hold bearings in place. Bearing sometimes moves perceptibly when loosened, even when motor is not running, and belt is off.

REMEDY.—Loosen by partly unscrewing bolts or screws holding bearing in place, and find its easy and true position, which may either require it to be moved sideways or

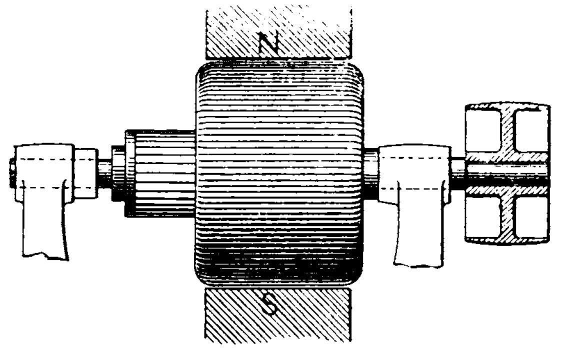

FIG. 7.—ARMATURE FORCED AGAINST BEARING.

up and down; then file the screw holes in the bearings or raise or lower the bearings, as may be necessary, to make them occupy right position when screws are tightened.

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7. Cause.—*Thrust or pressure of pulley collar or shoulder on shaft against one or both of the bearings.* (Figs. 6 and 7.)

Symptom.—Move shaft, while revolving, back and forth with the finger or a stick applied to the end, and note

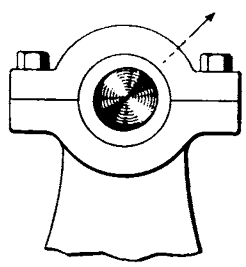

FIG. 8.—BEARING WORN ELLIPTICAL.

if collar or shoulder tends to be pushed or drawn against either bearing. A dynamo or motor shaft should always be capable of moving freely back and forth a sixteenth or eighth of an inch to make commutator and bearings wear smooth (See Sparking, No. 3). If this does not occur it should be relieved in one of the following ways:

REMEDY.—Line up the belt, shift collar or pulley, turn off shoulder on shaft or file off bearing until the shoulder does not touch when running or until pressure is relieved.

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8. Cause.—*Too great load or strain on the belt.*

Symptom.—Great tension on belt. In this case pulley bearing will probably be very much hotter than the other and also worn elliptical, as indicated in Fig. 8 in which case the shaft may be shaken in the bearing in the direction of the belt pull, provided the machine has been running long enough to wear the bearings.

REMEDY.—Reduce load or belt tension, or use larger pulleys and lighter belt or even gearing so as to relieve side strain on shaft.

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9. Cause.—*Armature too near one pole-piece, producing much greater magnetic attraction on nearer side.*

Symptom.—Examine the clearance of armature and see if it is uniform on all sides. Charge and discharge the field magnet, the armature being disconnected (by putting paper under one brush), and see if armature seems to be drawn to one side and turns very much less easily when field is magnetized.

REMEDY.—This fault is due to an inherent defect in the original construction, which is difficult to correct, but in cases of necessity the armature can be centered exactly in the field by moving the bearings, which may be done by carefully filing the holes through which the screws pass that hold the bearings in place, or the pole-piece may be filed away where it is too near the armature. It is sometimes possible to spring the pole-piece further away from the armature, but it is difficult and dangerous to attempt.

DEFECTIVE INCANDESCENT LAMPS.

BY

Otis K. Stuart

SAID the manager of a central station to me, not long ago: "I don't know what we are going to do. This incandescent lamp problem is a serious matter. This company spent over $800 last year merely experimenting with different lamps!"

Now, considering the fact that his plant operated only 5,600 lamps, this amount was large and, doubtless, quite exceptional; but the experience of lamp salesmen proves that a large sum of money is annually spent by the various central station companies of the country for the mere "testing" of different makes of lamps. If this expenditure really proved of any permanent or substantial benefit to the consumer, or to the central station itself, there might be good warrant for it; but on it goes month after month, year after year, while the stations still use the lamps of a number of makers, and the station managers are as much in the dark as ever.

A few weeks ago I asked the superintendent of a large station what kind of a lamp he wanted. His answer was, "I want the best lamp that's made!" Now, there are a good many "best" lamps, and not every lamp manufacturer makes the best of every variety, though nearly all of them make nearly every variety of lamp. One maker has high efficiency, with good average life, in the higher voltages, while his low-volt lamps are comparatively poor. He pays special attention to the former, and turns out the latter almost because he must; or his head lamp-maker may be a "crank" on the higher-volt lamps; or *vice versa.* Another manufacturer makes lamps giving very long life and poor efficiency—for the two always go together—and his efficient lamps may not last 300 hours on an average. The incandescent lamp at its best is a somewhat uncertain product, and the fact is that in this line "a man cannot have the penny and the cake, too!" It should be pretty well known now that a 3-watt lamp will not last 2,000 hours, or even very near it.

But the decided expression quoted from the station superintendent was not an exceptional, though it was a random, shot. Let us be frank. Not all central station men, even, know exactly what they do want. And sometimes they are satisfied that what they were sure they *did* want is not what they want in the future. And it *is* rather difficult for the lamp manufacturer to know under what conditions his product has been used. So the manufacturer is forced to bear a considerable part of this expense of "testing," and the question "What is a defective lamp?" frequently remains unsolved, to his loss and his customers' dissatisfaction.

It may be stated in all fairness that nearly every ill with which electric dynamos, and the line and other apparatus, too, for that matter, are afflicted has its bad effect upon the lamps. A "ground," the sudden throwing on and off of loads (especially on motor circuits), changes in speed of generators, bad regulation of transformers, and the ignorance of station men and lamp users, are not the only causes which decrease the life and light of incandescents; yet the manufacturer is often the loser, in the form of defective lamps, from just these very causes. If a lamp burns out within from one second to one hundred hours, it is often classed as "defective," though the voltage of the circuit may be from 20 to 2 volts too high. If a filament burns "yellow" the lamp is said to be defective, though the eye is a notoriously bad photometer, and the voltage may be too low. This question of the voltage of a circuit is so puzzling sometimes that a man might believe the structure of the wire changes with the seasons or the weather! How much the incompetence and dishonesty of constructing engineers has to do with the deplorable condition of hundreds of circuits it would be interesting to know. It was the A B C class, I think, in which we learned the law that a number 10 wire will not carry a thousand amperes with the same "drop" as a number 9!

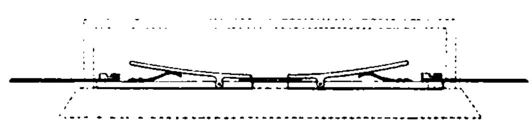
Then, plaster of paris will not often stand a tensile strain of 10 tons to the square inch, though one might be pardoned for thinking so after seeing it resist the pull of lineman Hercules in his endeavor to force lamp from socket sometimes. And glass is brittle, especially very good glass.

The sealing of a carbon filament to platinum wires is a delicate operation, and the joint is "sensitive," no matter how tough the filament itself may be. Incandescent lamps can never be used successfully as base-balls; but they make better plating apparatus, only the color of the "plate" is suggestive; and if lamps do blacken finally, nature must be blamed for not giving us a better substance for filaments than carbon, or man for not finding one.

A reputable lamp manufacturer is certainly as much interested in making the best possible product as the central station manager is in using it, and with the great improvements which have been made within the past three years in incandescent lamp-testing apparatus, it is not a difficult or very expensive operation for him to know accurately the condition of the lamps he is shipping. If central station managers would always accurately state just what sort of lamp they want, and would always be sure beforehand that what they think they want is the best for their purpose, they and the manufacturer would be much better satisfied, and richer by (in the case mentioned above) about $800.00 + a year.

THE HOWELL ELECTRIC SAFETY CUT-OUT.

CONSIDERABLE difficulty has been experienced in the protection of electrical instruments wound with fine wire,



HOWELL ELECTRIC SAFETY CUT-OUT.

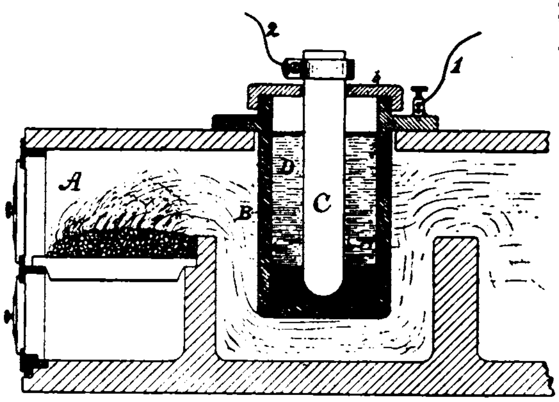
such as comparative indicators, telephones, telegraphic apparatus, etc., since with metal wire of sizes which can be practically made and handled, the instruments will frequently be destroyed or injured before the safety-catch wire is fused, due to the fact that the heat is conserved in the closely-compacted coils.

With a view to correcting this trouble, Mr. John W. Howell, of Newark, N. J., employs for a cut-out a material which, while it is a conductor of electricity, has a high specific resistance compared with the metals, and which is destroyed by chemical action, as distinguished from fusion, when an abnormally large current passes through it.

For this purpose Mr. Howell employs a carbon filament, held in spring clamps, as shown in the accompanying illustration. A cut-out of this character, by reason of the high specific resistance of the material, can be constructed of a large size, compared with one of metal which would respond to the same current. It has been found that these cut-outs can easily be made to open the circuit when a current of one-tenth of an ampere, or even less, is flowing, and still be of an entirely practical size for handling.

EDISON'S DIRECT METHOD OF GENERATING ELECTRICITY FROM CARBON.

A METHOD of generation of electricity directly from carbonaceous material, without the loss caused by the double conversion of heat into mechanical, and thence into electrical, energy, is described in a patent recently issued to Mr. Edison, the application for which was filed May 26, 1882. The method consists in employing carbonaceous material for the soluble electrode of a generating-cell, and using as an active agent oxides, salts, or compounds of elements, by the decomposition of which the carbonaceous material will be acted upon at high temperatures. Heat is applied externally, and the negative electrode of the cell is made of a substance which in the presence of carbon at high temperatures is not attacked to any great extent by the active material employed.



APPARATUS FOR THE DIRECT GENERATION OF ELECTRICITY FROM CARBON.

The accompanying illustration shows the apparatus employed. As will be seen, A represents a furnace for heating the iron melting-pot B, and C is a cylinder of carbonaceous material resting on the fire-clay block *a*. The cover of the pot is also of fire-clay. The circuit connections 1 2 are made with the pot and carbon cylinder.

The heat of the furnace fuses the oxide at the same time that it raises the carbon to a temperature at which it combines rapidly with oxygen. A reduction of the oxide takes place, the oxygen combining with the carbon and forming carbon monoxide, which passes off and may be conducted to the combustion-chamber of the furnace and used for fuel, it being burned to carbonic acid, while the metal is carried to the other electrode and deposited upon the walls of the containing vessel. During the oxidation of the carbon an electric current flows through the circuit of the cell. The product of the reduction of the oxide may be reoxidized and used over again as the active agent of the cell.

ELECTRIC TROLLEY RODS IN EUROPE.

CONSIDERABLE difficulty has been experienced in designing a trolley rod which shall bend up and down, to the right or left, without leaving contact, and at the same time be cheap and simple. Many scores of designs of various principles have been made, but nothing simpler or cheaper, as far as Europe goes, has been proposed than that used on the Schuckert overhead line at the Frankfort Exhibition, which consists simply of an ordinary coiled conical spring (such as is made by slitting a metal tube helically), one end fixed to the roof of the car, and the other bearing a socket for the trolley rod. This arrangement has no need of adjustments, is perfectly flexible, and gives no trouble whatever.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—XVI.

BY

Chas. Steinmetz.

WE must leave it to the reader, to go over the changes of the electric and magnetic quantities of the transformer, which are caused by changes of its constants, r_1, r, n n_1;

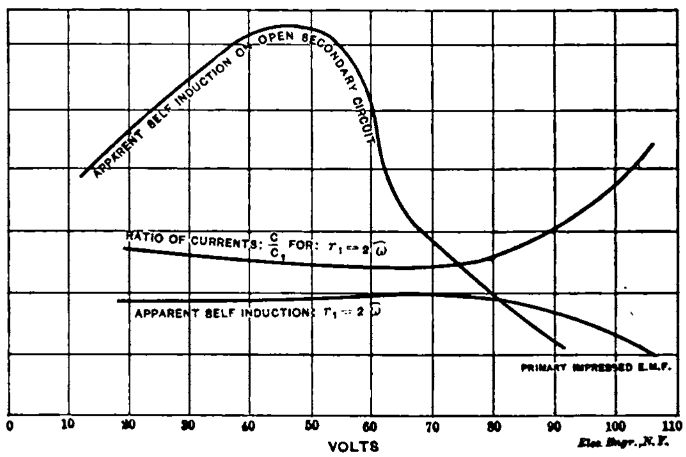


FIG. 29.

N, etc., in the same way as we did—in the simple diagram—in chapter VI., but now with due consideration of the variability of magnetic susceptibility, and give only in Fig. 27 the diagram of the transformer for the secondary resistance, $r_1 = 2$ ohms and in Fig. 28 the diagram of the transformer for open secondary circuit, with the curves of the electric quantities depending upon varying primary impressed E. M. F.

Table II.—Iron-clad transformer, open secondary circuit, $r_1 = \infty$.

Resulting M. M. F., in ampere-turns.	Primary M. M. F. — impressed M. M. F., in ampere-turns.	Resulting, or heating primary E. M. F., in volts.	Impressed primary E. M. F., in volts.	Primary current, in amperes.	Ratio of transformation of E. M. F.'s.	Apparent self induction.		
F	$L^\infty - K$	E^∞	E_0^∞	C^∞	$\frac{E_0^\infty}{E_i}$	$\frac{E_0^\infty}{C^\infty}$	Secondary M. M. F. M. M. F. of eddy-cur-	The same as in Table I.
114	146	1.5	15.4	3.6	1.02	4.28	rents.	
168	230	2.3	31.5	5.7	1.03	5.53	Ideal M. M. F. of hyster-	
230	294	2.9	46.9	7.3	1.05	6.42	esis.	
342	560	5.6	62.3	14.0	1.07	4.45	Ideal M. M. F. of iron-	
476	812	8.1	65.8	20.3	1.07	3.24	cores.	
1520	1540	15.4	79.1	38.5	1.08	2.05	Induced E. M. F.	
3100	3140	31.4	91.0	78.5	1.12	1.16	Magnetization.	

From these Figs. 27 and 28, we derived the values of transformer quantities, corresponding to different resulting M. M. F's, which are given in Tables I. and II. I. for secondary resistance, $r_1 = 2$ ohms, and II. for open secondary circuit.

The ratio of the currents, $\frac{C}{C_1}$ for $r_1 = 2$ ohms, and the apparent self-induction, or the impedance of the primary circuit, for the secondary resistance, $r_1 = 2$ ohms as well as for open secondary circuit, $\frac{E_0}{C}$ and $\frac{E_0^\infty}{C^\infty}$, are shown separately in Fig. 29, as functions of the primary impressed E. M. F., E_0, to show by ocular demonstration, the necessity of considering the variability of magnetic susceptibility.

For, assuming the magnetic susceptibility μ as constant, the three curves in Fig. 29, $\frac{C}{C_1}$, $\frac{E_0}{C}$, $\frac{E_0^\infty}{C^\infty}$, are assumed as three straight horizontal lines.

In reality, in the small range produced in Fig. 29, the different values vary considerably; especially the impedance of the primary coil goes down from 6.42 to 1.16; that is to about one-sixth its maximum value, and decreases for higher impressed E. M. F. still faster, so that for higher impressed E. M. F. the transformer acts as an entire dead short-circuit of apparently no self-induction. This brings up another important point, how far—supposing the insulation will stand it—the impressed primary E. M. F. can be raised, to produce an increase of the induced secondary E. M. F.

As seen from Fig. 29, so soon as the primary impressed E. M. F. oversteps 50 volts, for open circuit, the impedance goes rapidly down, and the primary current increases quite out of proportion to the impressed E. M. F., while the secondary E. M. F. increases only slowly. Near 80 volts the impedance of open circuit goes down even below that of the loaded transformer, and the paradox appears, that the *primary current for open circuit, the so-called "leakage-current," is larger than the primary-current of the loaded transformer—the impressed* E. M. F. *being the same*, so that, by taking current off from the secondary circuit, we actually *decrease* the primary current.

In Table I., the primary current, $C = 58.1$ amperes, corresponds to the impressed E. M. F., $E_0 = 92.4$ volts; in Table II., the impressed E. M. F., $E_0^\infty = 91.0$ volts, corresponds to the primary current, $C^\infty = 78.5$ amperes, and hence, to $E_0^\infty = 92.4$ volts corresponds $C^\infty = 87$ amperes.

Therefore in this transformer at open circuit, a primary E. M. F., $E_0^\infty = 15.4$ causes a primary current, $C^\infty = 3.6$ amperes; 46.9 causes a primary current 7.3 amperes, hence, to double the current we have to increase the E. M. F. threefold. $E_0^\infty = 92.4$ causes a primary current, $C^\infty = 87$ amperes. Doubling now the impressed E. M. F., the current is increased 12 fold. But, taking off now from the secondary circuit, 36.9 amperes, we *decrease* the primary current from 87 to 58.1 amperes.

The reason for this phenomenon is simply, that, by taking secondary current off, we decrease by the secondary counter M. M. F. the resulting M. M. F., and thereby the magnetization, from high saturation to beginning saturation. This curious phenomenon is one of the many paradoxes due to magnetic saturation, into which I cannot enter more deeply now.

Table I.—Iron-clad transformer, secondary resistance, $r_1 = 2$ ohms.

Resulting M. M. F., in ampere-turns.	Secondary M. M. F., in ampere-turns.	Primary M. M. F., in ampere-turns.	M. M. F. of eddy-currents, in ampere-turns.	Ideal M. M. F. of hysteresis, in ampere-turns.	Ideal M. M. F. of the loss of energy in the iron, in ampere-turns.	Impressed M. M. F., in ampere-turns.	Induced E. M. F. in volts.	Resulting, or heating primary E. M. F., in volts.	Impressed primary E. M. F., in volts.	Secondary currents, in amperes.	Primary current, in amperes.	Magnetization, in lines per square inch.	Ratio of transformation of E. M. F.'s.	Ratio of transformation of currents.	Apparent self-induction.
F	L_1	L	βE_i	$\epsilon E_i^{\cdot 6}$	$\beta E_i + \epsilon E_i^{\cdot 6}$	K	E_i	E	E_0	C_1	C	B	$\frac{E_0}{E_i}$	$\frac{C}{C_1}$	$\frac{E_0}{C}$
114	302	406	28	62	90	146	15.1	4.1	18.9	7.5	10.2	15,800	1.25	1.35	1.85
168	608	784	54	98	152	230	30.4	7.8	37.8	15.2	19.6	31,900	1.24	1.29	1.93
230	888	1106	76	118	194	294	44.4	11.1	54.6	22.2	27.6	46,600	1.23	1.24	1.98
342	1162	1442	98	138	236	560	58.2	14.4	72.5	29.1	36.0	61,100	1.24	1.24	2.14
476	1230	1568	110	142	252	812	61.5	15.7	75.9	30.7	39.2	64,600	1.25	1.28	1.94
1520	1476	2324	126	160	286	1540	73.8	23.2	92.4	36.9	58.1	77,500	1.25	1.57	1.60
3100	1626	3468	142	170	312	3140	81.3	34.7	105.7	40.6	86.7	85,400	1.30	2.25	1.02

THE USE OF THE MAGNETO IN TESTING.

BY

Chas. Hewitt.

In reading Mr. Ayer's paper read before the National Electric Light Association at Montreal, I notice that he permits the use of the magneto in testing his arc light circuits. The writer is well aware that this practice is quite general in central stations, and submits the following in order to show how useless such tests may be:

Some three years ago I had occasion to place an arc light cable in a creosoted wooden box underground. This cable had an ordinary okonite insulation covered with braid, but no lead or other covering was used. The cable was made under strong guarantees, and I was anxious to see what effect the creosoted wood had upon the insulation. I therefore made tests about every two or three weeks with a galvanometer and bridge, measuring the resistance accurately.

In making one of these tests I noticed a marked decrease in the resistance, and supposed at once that some fault had developed in the cable, but on further investigation I found that my assistant had not disconnected the dynamo from the cable, and in measuring again I found the fault was in the dynamo and not in the cable. Copper dust had accumulated on certain parts of the machines, and was forming an incipient ground. Now, these circuits were regularly tested twice a day with a magneto, and yet this incipient ground was not revealed in the slightest, while it was readily detected with a galvanometer. The dynamo attendant afterwards told me that he could feel a slight shock from the machine when adjusting brushes.

A more recent occurrence happened in Buffalo about three weeks ago, when the writer had occasion to test some electric cars. A certain car had been reported frequently by the motor man as having a ground on the switch. The switch was of the ordinary Sprague type. It had been tested several times by the expert in charge with the magneto, and not the slightest kind of a ring could be obtained. I tried the magneto myself upon the switch, testing every portion of it thoroughly, and could not get a quiver in the bell hammer; I then tried the galvanometer and bridge, using 15 cells of a Barrett battery. The fault was readily located, and was found to be due to the accumulation of some copper dust which was readily removed. Here, then, is a case where a man could feel the shock with 500 volts pressure, and yet absolutely no ring could be obtained from the magneto.

If such cases as the above can occur, how much more liable are faults in the interior wiring of buildings to be overlooked where the magneto is relied upon to test the circuits? There are numerous kinds of bridges and galvanometers that are almost as convenient to use as the magneto, and infinitely more reliable. Why not, then, relegate the magneto to its proper sphere, and use the more accurate and reliable instrument?

ECONOMY IN ELECTRIC POWER DISTRIBUTION.

BY

J. Stanford Brown.

MR. H. WARD LEONARD in his article entitled "Minimum First Cost of Plant and Maximum Economy of Operation in the Electrical Transmission of Power," appearing in THE ELECTRICAL ENGINEER of Sept. 2, has thrown the gauntlet, as is evident from the discussion to which that article has given rise. In all discussions it is necessary to start from given premises to which both sides will agree.

Mr. Sprague's "laws" are based on the familiar formula $C.\ M. = \frac{15.666\ n\ l}{E\ V\ \alpha}$ and using the same abbreviations Mr. Leonard's

$$C.\ M. = \frac{K.\ W. \times D \times 21{,}400}{V\ (E - V)} \text{ becomes } \frac{K.\ W. \times l \times 21{,}000}{E\ V}$$

The difference between them is that in Mr. Leonard's formula α, the motor efficiency is omitted, and that Mr. Sprague uses 10.5 instead of 10.7 for the mil-foot of copper resistance. They can be written as follows:

$$\text{Sprague} \quad - \quad - \quad - \quad \frac{(2\ l)\ (10.5)\ (n \times 746)}{E\ V\ \alpha}$$

$$\text{Leonard} \quad - \quad - \quad - \quad \frac{(2\ l)\ (10.5)\ (1{,}000 \times K.\ W.)}{E\ V}$$

Mr. Leonard, desiring to figure in kilo-watts, reduces his horse-power thereto by dividing by 1,000 and then introduces the factor 1,000 in his constant to get them back again to horse-power.

The question is, *Can the motor efficiency be neglected* in figuring the amount of wire? Perhaps by using a "general formula" Mr. Leonard is dealing with an "ideal machine." Commercial motors under average conditions of practice will not, as a rule, give over 80 per cent. efficiency. Mr. Thomas J. Fay found in 50 stationary motor installations in actual practice an average motor efficiency of 75.1 per cent.

In short, if any given set of conditions with

$\alpha = 100$ require $C.\ M. = x$, then for

$\alpha = 90$ they will " " $= 1.11\ x$ or 11 per cent. more copper.

$\alpha = 80$ " " " $= 1.25\ x$ or 25 per cent. more copper.

$\alpha = 75$ they will require $C.\ M. = 1.33\frac{1}{3}\ x$ or $33\frac{1}{3}$ per cent. more copper.

$\alpha = 70$ " " " $= 1.45\ x$ or 45 per cent. more copper.

Will not a formula yielding such results give an excessive "minimum first cost of plant"?

THE FRANKFORT ELECTRICAL CONGRESS.

BY

L. Gutmann

THE second day's session in Section 2, devoted to Heavy Currents, was opened by the reading of a paper on "Electric Transmission of Power by Means of Alternating Currents," by Mr. v. Dolivo-Dobrowolsky. The subject was inviting and the hall was crowded. Mr. v. Dobrowolsky spoke principally of matters already published, and well known to American readers. On that account the discussion that followed turned to kindred subject-matter. Mr. Déri took the stand that Prof. Ferraris, of Turin, was the original inventor of the rotating field (Drehfeld) system, and had explained the same to him (Déri) in 1885. Engineer Corda, of Paris, called attention to the motor of Mr. Leblanc, who obtained the rotary field by employing a condenser with one winding of a multipolar motor. Prof. S. P. Thompson said in favor of the three-phase motor, that the principal points of advantage over the alternating-current motor are that it starts from a state of rest, has less loss with the same weight of copper, and an exciting field of uniform strength. Of all multi-phase motors those with three wires are the best because three wires are not objectionable. Multiplying the number of phases could still further increase the constancy of the field, but increasing the wires to four, five, or more would complicate matters and would not be a commercial success. Mr. Kapp called attention to the solid construction of motors and dynamos used in the Lauffen-Frankfort stations, and said that not sufficient attention had been called to the fact that generator and motor work with exceedingly low pressure.

On the third day, Sept. 10, several matters of considerable importance were submitted, the first being the "henry." This proposition and some arguments had been printed and distributed to all the members on the day before, so as to give them time for consideration. When the matter came up, however, the president, Dr. von Siemens, who, bye the bye, was of opinion that there were others more entitled to the honor than Prof. Henry, proposed that this matter should be submitted to Section I., and thence to a committee whose resolution should be submitted to the general assembly. The proposition was carried.

M. Hospitalier, of Paris, then rose and spoke of the desirability of the adoption of a universal code of symbols and expressions in electrical matters similar to those used in algebra and geometry. This matter is of more than ordinary importance, and is explained by a few of his arguments. He referred first to the fact that, if we read an algebraic formula or symbol, it explains itself, even if the reader does not understand the language of which the calculation or expression forms a part, as for instance: $(a + b)$ or $\int_o^t$, or $>$, or $=$. Nevertheless, in electrical literature, nearly every writer has his own method of expressions; he gives his meaning in the beginning of his work, and the reader, while fully conversant with the language, is nevertheless compelled to refer constantly to the key, to ascertain the meaning of the expression. For example, Ohm's law is written $C = \frac{E}{R}$, or $I = \frac{E}{R}$, or $I = \frac{E}{W}$, depending on the nationality of the writer; in a similar manner the expressions in various books, as for instance, those of M. Hospitalier, S. P. Thompson, Kapp, Hering and others, for the same thing, have a totally different appearance. M. Hospitalier having proposed his system in 1886, in Paris, and later at the British Association, without success, he therefore called attention once more to such a system at this Congress. This matter was also referred to a committee for consideration.

In the discussion that followed the necessity for such proposed modifications became apparent, as others drew attention to expressions which are continually giving trouble. Mr. Uppenborn proposed the universal adoption of a unit of power instead of the old-fashioned horse-power (H. P.) = 746 watts, which, moreover, has different values in different countries. The German P. S., or (Pferdestärke), the French C. V. (cheval vapeur) is equal to 736 watts. Prof. Kohlrausch proposed as a practical unit 1,000 watts or 1 kilowatt. In reply to this remark, M. Hospitalier said that in France the cheval vapeur of 75 kilogrammetres is about to be abolished and replaced by the "Poncelet," equal to 100 kilogrammetres, which differs from the kilowatt by about 2 per cent.

At the following session of Section 2, Mr. Hummel, electrician of Schuckert & Co., made an address on "The determination of the power absorbed in iron by magnetic and electric action." He described in particular two methods for measuring separately the various losses in the iron. The first consists in constructing two diagrams, when the dynamo operates with constant speed and variable magnetization, or vice versa. This method is suitable only when the mechanical work lost remains constant. If this is not the case, another method must be selected which admits of eliminating this loss. This is done by a supplementary machine, which compensates for the loss by mechanical work by means of a belt. At first the efficiency of this extra machine coupled to the dynamo under test has to be determined. The difference of the measurement found when the latter operates first with the field excited and then unexcited represents the mechanical loss.

The paper read by Dr. C. Heim, regarding "The Examination of Accumulators," did not disclose anything novel. On Sept. 11 Mr. Kapp explained a simple method for determining experimentally the losses by eddy currents and hysteresis independently of one another in dynamo armatures. These losses are different when the dynamo is running empty, and when loaded. Mr. Dobrowolsky stated that the same method is also applicable to transformers.

Mr. Lahmeyer then spoke on "New Constructions of Constant and Rotary Field Machines. The great objection to high-potential continuous-current machines, he claimed, was the sparking at the commutator, which he has overcome by connecting a resistance conductor between armature winding and commutator segments. The discussion disclosed the fact that this method has been used by the Edison Co. for some time.

Mr. Georges, engineer of Siemens & Halske, made some statements on "Experiments with Alternating Currents" made by that firm, and explained them by diagrams, showing that the greater the number of phases used, the more constant does the magnetic excitation remain.

Returning to the General Assembly, Prof. Weber, of Zurich, reported the result of the work done by the committee relative to the propositions of the American Institute of Electrical Engineers and those of Mr. Hospitalier. I would like to mention, however, beforehand the work of the committee more in detail. Mr. Hering, one of the committee, proposed in the name of the American Institute of Electrical Engineers the "henry" for the practical unit of induction, the "gauss" for the practical unit of magnetic intensity (=1,000 lines per square centimetre), and the "weber" was proposed by Mr. Hering personally for the absolute unit of magnetic intensity. Since the work of Prof. Henry, or at any rate, its exact value, seemed to be not generally known among some of the members, the proposed name met with some opposition by some, among them Mr. Uppenborn and Prof. Weber, while Mr. Preece, Prof. S. P. Thompson, and others, speaking for the British Association, advocated the adoption of the name "henry." The members of the committee having had but two sessions, argued that the time had been too short, and that they would not like to rush matters of such importance to a decision without proper investigation. In consideration of these statements, and the non-agreement of the members, the matter was left open to receive proper attention at the next Congress, when a final decision will be given.

Prof. Weber reported that the proposition of naming the practical unit of induction the henry had been withdrawn. This statement was, however, modified by Prof. Kohlrausch, who said that the proposition was not withdrawn in the proper sense of the word, as the Americans were going to continue to use it, and that it would be brought up for reconsideration in the next Congress, held in Chicago. In regard to this matter, as also that regarding the uniform system of symbols proposed by Mr. Hospitalier, he said that every one should familiarize himself with these new matters so that at the next congress they could be settled finally.

In regard to the matter submitted by Mr. Hospitalier, Prof. Weber proposed for the committee that "quantities" should be expressed by letters in italic; "units" by Roman letters; and physical constants and angles by Greek letters. Further, the units of joule and watt, which have been in use since 1889, to be formally adopted, and to abbreviate the names volt, ampere, ohm, coulomb, farad, joule and watt by simply using the initial letter of each.

The final decision in regard to this matter the committee wished to have made by the next Congress.

This report was followed by the paper of Mr. Zipernowsky, who spoke on "Electric Railroads." He described a system contemplated for connecting Vienna with Buda-Pest, in which his company (Ganz & Co.) prefers the use of single cars as against trains, similar to our tramway systems. The speed is to be 250 kilometres per hour. The cars will follow each other every 10 minutes and be capable of carrying 40 passengers each. There are to be two generating stations at suitable distances apart, delivering current to the line at a pressure of 10,000 volts, which are reduced to 1,000 or 500 volts by means of converters placed every two kilometres. The cars will be very large and roomy, and are to be provided with the Westinghouse air-brake. For such a system the rails are made very heavy, and are mounted on brick foundations. In the following general assembly Prof. Heinrich formally invited the delegates to participate in the Chicago Congress of 1893.

Dr. Epstein then spoke about the position to be taken by electric laboratories or institutes making tests. He believed that no certificate should be given to a client sending his apparatus to be tested, which would enable him to use it for the purpose of giving wrong impressions to laymen, especially for apparatus which may be suitable for one special case and totally unsuited to another.

In the last session of Section 2, Mr. Wilking, of Schuckert & Co., spoke on accumulators in alternating-current stations. He pointed out that in cases where water-power or other prime movers are not made use of to their full capacity, the superfluous energy could be stored. To effect this he couples to the shaft of the alternator a continuous-current dynamo, which charges accumulators. This charge is afterward used to drive the dynamo as a motor, which in turn either drives the alternator alone, or helps the prime mover in operating the alternator.

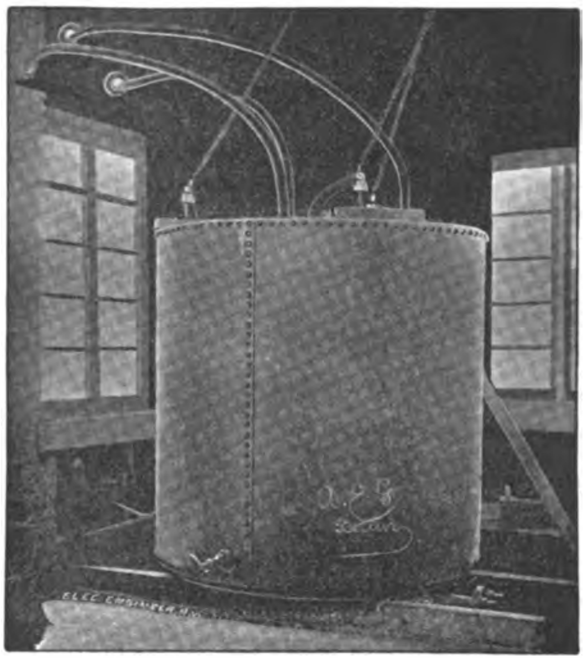
Engineer Baumgardt described graphically the efficiency of the compressed air (Luftdruck) system of power transmission, and showed that under very favorable conditions the system may pay.

Mr. Gutmann, of Pittsburgh, then spoke of the "rotary-field" system in America, and corrected several statements made in German periodicals regarding the non-use of alternating motors in this country, which did not agree with facts. In reply to his remarks on insulation tests of the Lauffen-Frankfort line, which he thought desirable, Mr. Lindley said that such tests were contemplated and would be published.

The Congress concluded with an entertainment in the Zoological Garden and an excursion to Lauffen.

THE LAUFFEN-FRANKFORT OIL TRANSFORMERS.

We have already entered very fully into the description of the transmission of power electrically from Lauffen to Frankfort, a distance of about 112 miles, and have given a number of views and diagrams of the apparatus used. Our readers will still be interested, however, in the accompanying views, which show the transformers as they actually appear. Supplementing our article of last week, which showed the interior of one of the transformers, it may be stated there are three transformers installed at Lauffen, one for actual use and the other two in reserve. At Frankfort there are also three transformers, all being in actual service, and receiving the current at a potential of 15,000 volts and upward. One of these, constructed by the Oerlikon Works (shown in detail last week), reduces the pressure to about 100 volts. This transformer is located on the left of the main entrance of the distribution hall. It furnishes the current for feeding 1,200 glow lamps, partly fixed to a large frame in the transformer-room, partly to a signboard outside the hall. The remainder of the current, corresponding to about 100 h. p., is reduced to



The A. E. G. Transformer at Frankfort.

the requisite E. M. F. of 100 volts by two transformers of the Allgemeine Elektricitäts Gesellschaft. These two transformers are located in a special shed on the right of the hall. The secondary currents furnished by them drive a large rotary-current motor of the Allgemeine Elektricitäts Gesellschaft (shown last week), as well as some other smaller motors of the same company. The large motor makes 600 revolutions per minute, and is coupled direct to a centrifugal pump, built by Messrs. Brodnitz and Seydel, of Berlin, which supplies a waterfall of 10 metres height on the right of the hall. Thus part of the electrically-transmitted energy makes a perfect cycle. A waterfall at Lauffen is the starting point of the energy, and part of

Oerlikon Transformer at Frankfort.

this latter is again seen in the form of a waterfall at Frankfort.

CALLENDAR ELECTRIC PYROMETER.

In a recent number of the *Philosophical Magazine* Mr. H. L. Callendar describes a modified form of the well-known Siemens electric pyrometer. In the Siemens pyrometer the zero is known to change largely and continuously. Mr. Callendar, however, points out that this effect is due to imperfect design, and he claims that if the wire is pure to start with, and is protected while in use from strain and from contamination, its resistance, after having once been annealed, is always very nearly the same at the same temperature. Mr. Callendar's improvements in the platinum resistance thermometer, or pyrometer, consist in the better protection and treatment of the platinum wire. This is differently treated according to the heats to which it is to be exposed. Two recent communications to the Royal Society related to investigations carried out with the aid of the platinum thermometer.

THE FAURE ACCUMULATOR PATENT IN GERMANY.

The action for the annulment of the Faure patent brought against the Joint-Stock Accumulator Company, of Hagen (Westphalia), by the Berlin Accumulator Company, Correns and Co., de Khotinsky, Gelnhausen, and Gottfried Hagen, of Cologne, came before the Imperial Patent Office a short time since. All motions made by the petitioners for annulment, in order to obtain a postponement of the case, the institution of experiments, hearing of witnesses both in this country and abroad, were disallowed, it being decided that sufficient material was already before the court to admit of a decision being arrived at. The Imperial Patent Office granted the demand of the defendant's counsel that the appeal lodged by the petitioners should be disallowed, thereby declaring the validity of Faure's 1881 patent to be unconditional.

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VOL. XII. NEW YORK, OCTOBER 7, 1891. No. 179.

The people in combination with men of genius—this will be the voltaic pile of civilization.—Lovett.

ELECTRIC RAILWAY SOCIOLOGY.

AMERICANS are a practical people, but that they are no less a people of ideas is shown in the zeal with which they throw themselves, body and soul, into new enterprises. This willingness to assume risks and take chances presupposes a vivid imagination that sees through and over difficulties to the triumphs and successes beyond, and so sane that it can forecast definite results even while the new project is in an embryotic stage. Contradictory as these two qualities of practicality and ideality may be, they present themselves very strikingly in many of the new enterprises that distinguish American growth, and have nowhere been displayed more forcibly than in the rapid advances made by the electric railway, whose realization on a large scale for the public benefit, and as a new source of wealth, is at this present moment almost wholly American.

There are sociological aspects to electric railway work that deserve close study, the more because they show a remarkable interplay of motives, some hard and practical, looking to the mere increase of dollars, others high-pitched, looking to the public welfare and the betterment of social conditions. The street railway man has adopted electricity with such overwhelming unanimity on account of its greater economy and greater earning capacity. The public have welcomed it because it promotes comfort and intercourse, saves time, gives men employment of a refining nature, releases the horse from torturing labor, adds to the value of property, and knits the community closer together.

If this be the case, it should in part at least be demonstrable by statistics, and certainly, so far as the change from horse, steam, and cable to electric locomotion is concerned, no figures could be more notable, while none are easier to obtain. They have often been given in these columns, and of necessity are frequently quoted. But the other figures—those bearing on the gain to the public—are not readily gathered, and for this reason the presentation of them made by Mr. Oscart T. Crosby in our issue this week is very valuable. We have in his address before the Thomson Scientific Club a serious attempt to express in figures the benefit derived by society from the introduction of the electric railway, and it must be said that the analysis is carried forward to a degree, and with a clearness, that one would hardly yet look for. Thus, for example, Mr. Crosby shows that the simple saving in operating expenses of 4 cents per street car mile means a saving to society of $19,600,000 per annum, and at the rate of $1 per day as the average value of a day's work, an array of 53,700 men now engaged in all the departments of street railway work, from first to last, could be re-distributed for other economies in other departments of labor; or, better yet, the gain would count for greater leisure. Next comes the gain from acceleration of speed in travel, and this Mr. Crosby shows to amount per day to 16,000 days of 10 hours each. This added to the other gain represents an economy of 69,700 man-days per day.

Nor is this all, for there are many shiftings of labor to be taken into account. The use of machines instead of horses, the consumption of coal instead of hay and oats, means a great deal as affecting agriculture and mining; and so it goes, all through society and social conditions. to another is not a small matter, especially when it is being The shifting also of 80,000 people from one set of industries done with the rapidity now noticeable in the adoption of electricity. Most of these people have hitherto earned a living by the sweat of their backs; they will now earn it by the sweat of their brow, and will be the better for the change.

INCANDESCENT LAMP ECONOMIES.

A PITHY article by Mr. Otis K. Stuart in this issue deals with light touch, but in a suggestive manner, with one or two points of economy in the purchase and use of incandescent lamps. As Mr. Stuart hints, there is still too much uncertainty in the tests, and indefiniteness in the results, of lamps tried by station managers, and yet the process of trial goes on, and scores of managers are spending thousands of dollars on a game that is not worth sixteen candles. There ought to be a better way of getting at the results they want, and much is to be hoped from the general spread of knowledge on photometry; but the manufacturers and the consumers have hardly yet agreed on the prime essentials of the perfect lamp.

Another point touched on in passing, by Mr. Stuart, is the ill-treatment that lamps receive. We would greatly like to see figures from some large factory, office building or hotel, showing the manner in which lamps have become *hors de combat.* In other words, it would be instructive to know how many lamps fail from natural causes or causes arising from defective manufacture, and how many succumb to careless handling, blows, shocks and "accident." Perhaps if the data were obtainable in some factories, it would be found that the high percentage of lamp breakage complained of was due not to the lamps themselves, but to the people using them. It is a notorious fact that lamps last longer when they have to be renewed by the persons directly using them.

An incident that occurred a week or two ago at Spokane brings to light a new danger for the lamp, and that is, theft. It appears that a place of business in that city lost several of its lamps, and that the place being watched, a "dope fiend" was caught stealing them in order that he might sell them for opium or morphine. It seems to be only a natural precaution that sockets should be watched and lamps counted regularly; but it would be more difficult to keep track of any one who should make a practice of withdrawing good lamps and sticking old ones up in their stead.

LIGHTING CIRCUITS ON ELECTRIC RAILWAYS.

The fact that the electric roads in Cleveland are prepared to do electric lighting, and are negotiating with the city government for the illumination of the 50 miles of streets through which they run and of adjacent thoroughfares, has excited some comment in the newspapers. In Cleveland, it was supposed that even if the railroads were able to utilize their circuits in this way, the terms of ordinances and charters would forbid, but the corporation counsel has decided that they have full legal authority.

The matter is one of interest, and we look for a rapid development of this method of street lighting, for the electric railway should very often be able to take contracts at lower rates than usual, and thus, in outlying districts, if not elsewhere, be able to compete favorably with existing lights, particularly those of oil and gas. The perfection of arc lights for use on incandescent circuits has had much to do with this condition of affairs, and we know of several instances where such lights are giving admirable results of constant potential electric railway lines. Of course it is desirable that the road shall be one of fairly large average load, and also one where the cars run through the night; but it seems to us that in many cases the undertaking of street lighting service will enable the railway companies not only to keep more cars going, but to operate all around the clock. Thus with a service to stationary motors during the day, and to arc lamps at night, the electric railway company will see the curve of its load diagram flattened out at a high level of amperes with an exhilarating increase in the margin of profit.

BIG POWER UNITS IN BOSTON.

Last week the biggest engine in New England was started up at the new power station of the West End Railway Co., of Boston. It is an Allis-Reynolds, of the Corliss type, of 2,000 h. p., triple expansion, the first of thirteen colossi, which will drive Thomson-Houston generators of 500 h. p. each. The whole will constitute a magnificent demonstration, when finished, of mechanical and electrical engineering skill, and they who have been concerned in the work are to be complimented upon their enterprise. This work may be said to mark the highest point yet attained in America in electric current generation, and it will be very interesting to see how much further the tendency towards big units will go. It is, we fancy, hardly expected yet awhile with us to reach what may be called the Ferranti limit. On the contrary, a reaction may in time be looked for, if only as a protest against the "craze" into which every new enthusiasm is destined to grow. There is a craze just now for big units, and while we all hope and look for great strides in this direction, it is not to be forgotten that there is much to be said on the other side, and that the scientific determination of what size these big units ought to be, in view of economic conditions and the present state of the arts, has not been ascertained. What one fears is that while the larger stations are thus wisely striving to get up to as large an economical unit as possible, smaller stations will be carried away by their example, and will be struggling under the depressing influence of units whose full capacity they will be several years in reaching, so that for a long time to come they will be working uneconomically. The tendency is all right, and is one to be encouraged, but a station with a maximum load of 5,000 lights worrying along with 10,000-light units is more a sign of retrogression than of advance. At least, the stockholders will be apt to think so.

Foreign Participation in the Chicago Exposition.

It has been feared by many electricians that there would not be a very active participation by foreigners in the Chicago World's Fair, and certainly our "high tariff' legislation would excuse European manufacturers from worrying themselves much about markets from which they were so severely excluded. But there are not wanting signs of an intention on the part of leading European countries to be well represented, and the welcome news now reaches us from Chicago that England and Germany each want 20,000 square feet in Electricity Hall, 40,000 each in Machinery Hall, and so on. This is not a small block of space, but we may depend upon it that it will be filled with apparatus well worthy of study.

Belts in Europe.

Mr. C. A. Schieren contributes another entertaining article in our columns on belting at the Frankfort Exhibition, and points out that none of the belts there exceed 20 inches in width, showing a preference for shafting over belts in the transmission of power. As he remarks, this is very different from practice in this country, where very large belts are in use in electric light and electric railway plants, and give general satisfaction as to efficiency and economy. Mr. Schieren's remarks on air spaces are also noteworthy.

The Philosophy of Earth Currents.

We commend for careful perusal Mr. Stevenson's article in this issue on earth currents in New York city. Mr. Stevenson has for some time had exceptional opportunities of studying this subject, and gives details of a number of phenomena. His word of caution as to the inferences drawn from the observations made, as bearing on the quality of underground cables, is sagacious and timely.

LEATHER BELTING AT THE FRANKFORT ELECTRICAL EXHIBITION.

BY

Chas. A. Schieren

JUDGING from the exhibition of machinery at the International Electrical Exposition at Frankfort, it is evident that the German engineers (and we may include all Europe) still largely favor the use of gears and direct transmission of power by means of shafting, rather than belting. The widest belt in motion at the Exposition measured about 20 inches, and was single ply. The whole exhibit contained only about a dozen belts over 10 inches wide, in operation; so that to a belt manufacturer interested in leather belting for electric lighting the Exposition was a great disappointment.

Cahn, Leudersdorf & Co., of Muelheim, had a fine example of leather link belting about 16 inches wide in operation, driving a dynamo of 100 h. p. from an engine of R. Wolf, of Magdeburg. This link belt attracted universal attention by its perfect and easy running; it was made on the American patent joint plan. There were two other link belts, 6 and 12 inches in width, respectively, made by Tullis Bros., of Glasgow, running on the engines of Rustan, Proctor & Co., England. These link belts had only one steel bolt and no parallel joint. The advantage of a centre joint was very perceptible in a comparison of these belts, as not 75 per cent. of the surface seemed to touch the face of the pulley in the latter case, while the entire surface touched in the former. However, all of the link belts were very much admired for the graceful curve they made when in motion.

Schuckert & Co., of Nuremberg, exhibited two single belts 12 inches wide, running tandem, or one belt on top of the other, supplying power to two dynamos from one engine pulley. As a novelty in an exhibition, this may do well enough, but cannot be recommended for general use, because in the event of either belt breaking when in motion it would destroy everything within reach. Parkney & Wittekind exhibited a beautiful rope-drive on grooved pulleys, with excellent result.

There is a certain fitness of things which should be observed, especially at an exhibition, and a wide, large, main engine pulley covered with a belt one-half of its width, looks very cheap; such a pulley should have a correspondingly wide belt, or not more than a few inches margin at the most. At Frankfort most of the wide pulleys had narrow belts. One large main engine pulley made by Gebrueder Sultzen, of Switzerland, 38 inches in width, had two crowning centres to allow an 18 inch and 14 inch belt to run alongside of each other and to their respective centres; the belts worked perfectly straight, and ran accurately. This pulley was a fine piece of workmanship.

Most of the belts were single ply, made from heavy leather. Their irregular motion and heavy flapping confirms the experience of American electricians that single belts are unreliable, and not desirable for dynamos. Some of these belts when not in motion were very tight and hollow in the centre, a sure indication of being overstrained, and too weak to transmit the power required of them.

A genuine surprise to an American belt maker was a 14 inch heavy (European) double belt, sewed with eight parallel rows of white lacing, transmitting power to a dynamo, with centres a short distance apart. This clumsy belt ran remarkably easy and noislessly, and apparently without slipping. After watching it closely we came to the conclusion that the thick lacing stitched along the belt allowed considerable air to come between the belt and pulley, thus preventing the formation of an air cushion—another triumph for the idea of allowing air spaces in a belt, which principle is so practically illustrated in America by the perforated belt so extensively used now for dynamos.

Our European cousins who may pay us a visit (perhaps to the World's Fair in Chicago) will be surprised to see the large number of wide main driving belts used in the electric light plants of this country, transmitting immense power with perfect ease and comparative safety, and they will also find that the art of making these belts has almost reached perfection with us.

A SOLUTION OF THE BLOCK SIGNAL PROBLEM.[1]

BY

H. Ward Leonard

THE purpose of this article is to call attention in a cursory manner to the state of the signalling art, and to indicate, if possible, the lines it will be necessary to follow in order to make a thoroughly reliable and practicable block system for railways.

A careful study of the whole subject, with the help of some recent publications too lengthy to be condensed within the limits of a magazine article—including a series of articles in the *Railroad Gazette* compiled in a volume entitled "American Practice in Block Signalling," and a paper read by G. H. Paine before the New York Railway Club on April 16, 1891—leads to the following specification, indicating the desirable features of an automatic block system: 1. There should be signals both on the train and along the track. 2. The signals on the train should give a continuous and positive indication to the engineer. 3. The signals both on the train and along the track should be actuated from a source of energy constantly under the observation and control of the locomotive engineer. 4. The signals should be distinctive both by form and color, and should be audible under certain instances when desired. 5. Any two trains on the same block should each give a danger signal to the other. 6. The power for actuating the signals should be positive, strong enough to operate any desired signal, and should not depreciate and require renewal, as in the case of batteries. 7. The operation of the signal should not depend upon the movements of any mechanism beyond the observation and control of the locomotive engineer while at his post. 8. Any train should have to disregard more than one danger signal before being *able* to reach a preceding train. 9. Any locomotive engineer should be able to communicate with any station or any other train in the same block. 10. There should be a signal constantly before the engineer and in the locomotive cab whose indication will always be "danger" unless *all* his signals are working perfectly. 11. The form and color of the signal should change from "safety" to "danger" under the observation of the engineer as the train passes the signal. 12. The absence of any signal should indicate danger, but there should be a positive danger signal which would only and always give positive and continuous indications to both engineers when two locomotives are in the same block. 13. In case of failure of the train or track signals at any point, means should be provided whereby signals could be instantly sent to a following train. 14. A misplaced switch should set danger signals on any train in that block and also along the track in that block. 15. The signals should be the same by day or night, and any light at the signal should always indicate the presence of a locomotive in that block. 16. Any person should always be able to signal danger to approaching or receding trains in that block while it is out of sight and hearing and without any light or special apparatus.

About three years ago the writer suggested a block system, which, it is believed, would comply with the above specification, and with the hope that it may lead to improvements in practice, the following description of it is offered:

Divide the line of the railway into blocks, say one mile long. Make each block overlap the next one half way. Stretch a bare wire parallel to the track and continuous along each block. Thus a wire one mile long will start from the beginning of each block, and another parallel to the first will start at the centre of the first. There will thus always be two parallel conductors along the track, and a conductor will end, and a new one begin, at each half mile. The forward end of each mile length of conductor will be connected by a wire leading to a green incandescent lamp, and the other terminal of the lamp will connect with the ground. Similarly the rear end of each conductor will connect with a red incandescent lamp.

Upon each locomotive will be placed a generator of electricity of about 100 volts, that is, about the pressure of the incandescent lamps. This generator can be a battery, or, preferably, a small dynamo, driven by a small engine which is operated by steam from the locomotive boiler. One pole of this generator is grounded by making contact with the metal work of the locomotive. A

1. Abstract from *The Engineering Magazine*.

conductor leading from the other pole of the generator passes through an ampere-meter for indicating the current being generated, and thence on through a low-resistance series incandescent lamp, which, when supplied with the current of four of the track signal *lamps*, will operate at a moderate incandescence. After passing through the series lamp which we may call the pilot lamp, the current passes to a trolley carrying a large wheel made after the style of a bicycle wheel, and this wheel makes rolling contact by a concave rim upon the two parallel conductors stretched along the track.

Now it will be evident that if the generator be operated the electric current will pass through the pilot lamp and up the trolley to the two conductors; thence it will divide equally between the four lamps connected to these two conductors, passing through two green lamps ahead of the trolley, and through two red lamps to the rear of the trolley, the green lamps as well as the red being half a mile apart.

As the train moves forward, the trolley will finally roll off the conductor of the block it is leaving, and both the red and green lamp of that block will be extinguished. At the same time the trolley will roll on to a new block and the red lamp at the rear end of this block will light up just as the locomotive reaches it and will then pass to the rear. At the same time the green lamp at the forward end of this new block will light up at a distance of one mile off.

It will be seen that a following train would have to pass the two red lamps of the preceding train before a collision could take place; also that whenever two trains would get within a mile of each other the generators would be acting in concert to divide the combined loads of the two, and whatever the current of each had been previously, it would immediately become different, the generator having the higher pressure taking the larger portion of the combined load. Thus the pilot lamp of one locomotive would flash up, and its ampere-meter would indicate a greater current than usual, and this, by a contact on the ampere-meter needle, would cause an alarm-bell to ring in the cab. Similarly the pilot lamp of the other locomotive would be reduced in candle-power, the ampere-meter would show a reduced current, and the alarm would ring on the lower contact. At the same time the locomotive engineer of the following train would see before him the red lamps of the preceding train in addition to his own green lamps, and a rear guard on the preceding train would see in addition to the red lamps of his own train the green lamps of the following train. On each locomotive a line containing a high resistance is led from the trolley and around the generator to ground, and this circuit in shunt to the generator contains a telephone. It will thus be possible for either locomotive engineer to talk to another engineer preceding or following in the same block, and regardless of whether either, or both, are in motion. If telephones in the various stations be similarly connected from the signal conductors, communication can be carried on between the station-master and passing trains.

Now as regards the signals along the track, the incandescent lamps should be arranged in a proper signal-box, and the green lamp should show a vertical band of green lights whereas the red lamp should show a horizontal band of red light, thus giving a signal defined by both form and color.

Two possible objections which may be raised against this method of signalling are: First, the presence of a car on a track without any accompanying attendant would not give a danger signal as it would with a track-circuit system. This, however, is a rather remote contingency, and, in any event, could not lead to an accident with much loss of life. The unreliability of the track-circuit is so great in other ways, as to make this slight defect almost negligible by comparison.

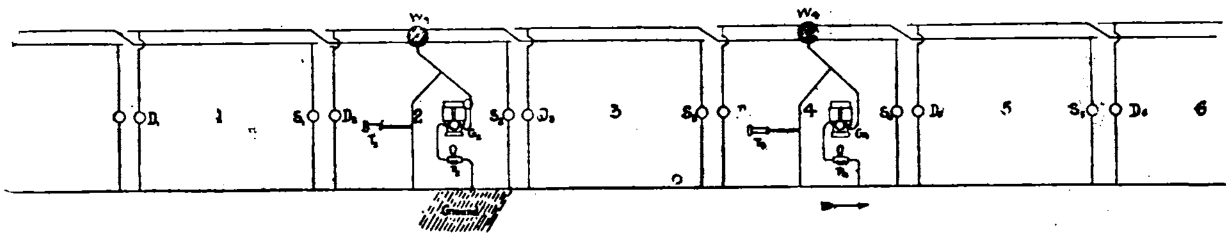
Second. The action of sleet might intefere with the action of the signal by preventing electrical contact between the trolley and wire. This trouble would be rare, in any event, and it is not likely to occur, as the heating effect of the strong current on the wire would tend to eliminate this trouble, just as it does with electric railway systems. If, however, it became necessary to provide against this, it could be done by placing the conductors beneath a semi-circular structure, such as a tube sawed longitudinally and concave downward.

It will be evident, by examining the specification as to the requirements of a safe system, that this plan avoids the defects of the present system.

The next consideration is as to its first cost and maintenance, and it will be evident that the advantages on these points are conspicuously in its favor, for the simplicity of the signals, and the cheapness of the small bare conductor, make its first cost less than that of any existing system. The cost of operation will be almost *nil*, as there will be almost no need of inspecting signals, having no batteries, electromagnets, relays, weights, clockwork, compressed air, oil-lamps, or the various other possible causes of failure of the existing systems.

It will be evident that by connecting along the signal conductors white incandescent lamps, and increasing the size of the generator, the track can be perfectly and uniformly lighted both in advance of and behind the train as it moves forward; and that also all crossings and stations can be lighted while a train is within a mile of them. Two-and-a-half horse-power would in this way be all that would be necessary to keep a track illuminated by 16 c. p. lamp every 200 feet, and for a space of not less than half a mile in both directions from a moving train.

Trains having an electric plant for the illumination of the cars require a plant of about 15 h. p., so that the additional power required in such a case would be hardly worth mentioning, and no special generator beyond that for train lighting would be needed.



D_1, D_2, D_3, etc., are the red lamps connected to rear ends of the sections 1, 2, 3, etc., respectively. S_1, S_2, S_3, etc., are the green lamps connected to the forward ends of the sections 1, 2, 3, etc., respectively. G_2 and G_4 are the generators on trains in sections 2 and 4 respectively. P_2 and P_4 are the Pilot lamps in series with the generators and placed in the locomotive cabs. T_2 and T_4 are the telephones. W_2 and W_4 are the trolley wheels making connection between the signal conductors and the generators.

Under the conditions shown in the diagram the train in section 2 will light its Pilot Lamp P_2, the forward green lamps S_2 and S_3 and the rear red lamps D_2 and D_3. The preceding train in section 4 will light its Pilot Lamp P_4 and the forward green lamps S_4 and S_5 and the rear red lamps D_4 and D_3.

MR. LEONARD'S PROPOSED BLOCK SYSTEM.

THE ELECTRIC RAILWAY FROM A SOCIOLOGICAL POINT OF VIEW.[1]

BY OSCAR T. CROSBY.

ASSUMING $1 to represent the value of "one man-day" as a unit, that being the worth of the labor that could be done, Mr. Crosby said: "There now 33,700 street railway cars of all kinds in operation. They make, per annum, about 490,000,000 miles of service. It will not be far from the mark to assume that four cents per car mile is the economy to be effected by the universal use of electric cars instead of horse cars. The saving to society in such a case is expressed in money at about $19,600,000 per annum. Now, applying our unit of man-days, this means that 19,600,000 of man-days of labor may every year be withdrawn from present industries without diminishing the total product of society in the shape of things desirable to eat, drink and wear or read. Otherwise expressed, it appears that 53,700 men who are now at work, engaged directly or indirectly in street car propulsion, may, every day after the substitution, stop working."

Mr. Crosby then went into a careful and elaborate discussion of the effect of this direct economy, showing it to be valuable for purposes of rest, recreation and greater luxury or comfort for society at large, if not immediately for the individual. So far, the saving in time by invention over old methods had been devoted to increase of production, but there was a tendency to utilize some of it now for increase of leisure. Part of the money benefit inured to the stockholders in electric roads. In Massachusetts there are about 105 stockholders to each of 45 roads. Taking the 1,100 roads, the country over, that would make 115,000 street railway stockholders in the United States, affected favorably in their incomes, ways of life, and ability to promote enterprises, by the higher returns from electric roads.

Having thus seen what may be called the most general effects, let us now glance at the redistribution of some of the social forces connected with this change. To make the car mileage above mentioned, viz., 490,000,000 per annum, there must be burned about 900,000 tons of coal; that is on the basis that one horse-power hour at the station is a close equivalent to 1.25 car mile, of service on the line, and that one horse-power hour of energy may be produced by five pounds of coal. To get out this 900,000 tons of coal per annum will require the constant service of 1,200 miners, besides the services of the men engaged in the commercial handling and transportation of the coal to the power-houses.

1. Abstract of paper read before the Thomson Scientific Club, Lynn, Sept. 24, 1891.

Estimating the coal worth $2.50 per ton as thus laid down, the total supply of labor for coal amounts to 2,250,000 man-days per year, or about 6,200 man-days per day.

Estimating the repairs at 7½ per cent. on the whole cost of machinery, it would appear that something like 30,000 men per day may be occupied in furnishing repairs to engines, dynamos and motors for 33,000 cars. It should, of course, be borne in mind that in covering a general item, such as repairs, we must take into account some miners to furnish the raw material, some engaged in transportation, and some commercial men to direct and co-ordinate the industry.

For producing the steam and electric energy required by these 33,000 cars, there will be daily employed about 1,500 engineers and firemen.

The total of these items—coal, repairs and power-station—shows a demand for about 38,000 man-days per day.

For the manufacture of the original installations of 33,000 cars there must be employed 42,000 people per day, estimating that the work of installation shall extend over 10 years, and understanding that we have covered in this the engines, dynamos, motors and line material, but have not covered new cars, trucks or rails. We thus see that we must divert daily about 80,000 people for the next 10 years from previous occupations to the installation and maintenance of electric railways, just sufficient to replace cars now running. The number will doubtless not diminish after 10 years, on account of the tremendous growth of the country and the extension of car mileage, even for a given population as compared with the present figures.

As to just how this total of 80,000 will be divided among the various occupations, we may judge from the actual distribution of the total population of this country as reported by our census. Not having at hand the figures for 1890, I find from the census of 1880, that out of 17,500,000 people, men and women, engaged in the various occupations, 7,600,000 are reported as agriculturists; 3,800,000 in mechanics and mining; 1,800,000 in trade and transportation; 4,000,000 in professions and other personal services. [This last item covers all individual personal services, from the high-priced lawyer to the humble domestic.] Some such distribution as this would doubtless follow for the 80,000 whom we have discussed above.

The forces which are supplanted we may estimate about as follows: There are 4½ horses per car on all horse railways throughout the United States, or a total of 115,000 horses. The average life of these in service is five years, which requires a supply of 23,000 per year. To feed and groom the total number engaged at the rate of 50 cents per day costs $575,000 daily, while the supply of 23,000 horses per year at the rate of $150 each requires daily $9,500. These 67,000 man-days are then substantially diverted from their original use, of simply maintaining the horse as a motive power.

Some of these, of course, are merely re-engaged to feed and clothe the mechanical workers above mentioned, while also from among them we take the surplus which has been above discussed as resulting when the line of expenditures in the two cases have been compared throughout. It is fair to presume that a very large proportion of these 47,500 thus relieved are at present engaged directly in agricultural pursuits, and the surplus which may be set aside may be taken as supplied directly from the agricultural class. Or it may be put thus: A large part of those engaged in raising grain and horses are now to be drafted into machine shops to make motors, or, on a smaller scale, are drafted into coal mining, etc.

Going more into detail, it will doubtless be found that the transfer is more complicated than this; that the manufacture of electric motors and machinery will absorb a considerable part of the higher class of labor engaged in general mechanical pursuits, while the void thus left will be filled from the agricultural element. After all the changes have been made, it will doubtless be found that the ratio above mentioned between the various occupations will still hold nearly true, with a slight diminution in the numerical value of the agricultural population. In this the United States is considered as a society complete in itself, which is not strictly, but very nearly, true.

Leaving now this redistribution of forces, let us look at some other effects of the change. Supposing the average schedule of speed of horse cars to be six miles and electric cars to be nine miles per hour; the gain in time may be expressed as 3⅓ minutes per mile. During the year ending June 30, 1890, there was a total of 2,000,000,000 of passengers carried. The average distance traveled by each of these may be assumed as about half a mile, hence we have a saving of three and a half billion of man-minutes, equivalent to about 58,000,000 of man-hours, or 5,800,000 man-days; the day of labor taken before as at 10 hours. This for the whole year would amount to 16,000 man-days per day.

We have said this is saved, that is to say, it is saved from the time that would otherwise be spent on a street car in order to cover the same distance. Whether or not this saving will be given to work or to pleasure cannot be determined. If it is taken as of like value to the time which is specifically given to labor, then we may add to the 53,700 man-days, giving a total economy 69,700 man-days per day.

Beside the consideration here presented in figures, we have the indefinite but large value resulting from the more pleasurable sensation with which we are all familiar from riding on the electric cars, this due to the greater speed, which is in itself a satisfaction, and from the relief which comes from seeing that sentient organisms are no longer suffering in our service, and before our eyes.

ON THE RELATION OF THE AIR GAP AND THE SHAPE OF THE POLES TO THE PERFORMANCE OF DYNAMO-ELECTRIC MACHINERY.[1]

BY HARRIS J. RYAN.

(Concluded.)

In Fig. 9 the diagrams show the magnetic action of the armature of a 10 h. p. 110 volt motor, with poles fashioned as in Fig. 6. Measurements of the magnetic leakage were made on this motor, and the results indicate that the shape given to the pole corners avoided saturation in them even at full load. The double angle of lead was almost 60 degrees. The ampere turns embraced by it on the armature were partially compensated for by 9 series turns on each of the consequent fields. The remainder of the armature ampere turns that lie between the double angle of lead ser ed to weaken the field by just the amount required to produce

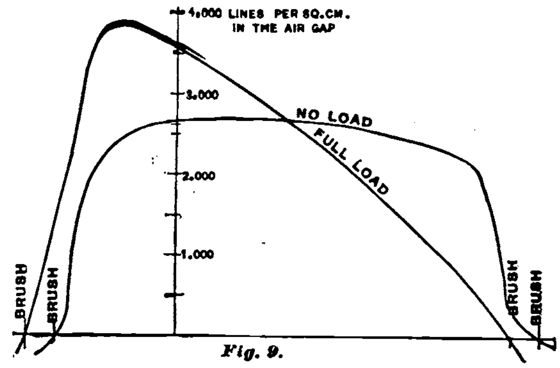


Fig. 9.

a constant speed. The following figures give additional data on this motor:

Diameter of armature core..................	8.33 in.
Diameter over all..................	9. in.
Bore of poles..................	9.38 in.
Double air gap..................	1.05 in.
Shunt turns on field..................	2200.
Shunt current at 110 volts..................	3.55
Ampere turns on field at 110 volts..................	7800.
Ampere turns on armature at full load..................	5750.
Armature sections..................	48.
Turns per section..................	3.
Speed..................	1200.

The ampere turns required to set up 2,600 lines per sq. cm. through a distance of 1.05 in. or 2.64 cms. in open air:

$$\frac{2600 \times 2.64}{1.26} = 5600.$$

This is the number of field ampere turns that exerted their magnetizing force between the pole faces through the armature. The ampere turns acting through the weakened pole corners are, therefore, very near zero, which is entirely corroborated by the fact that the magnetization was observed to be zero at this point. See full load curve in Fig. 9. Through the strong pole corners the ampere turns acting were the 5600 of the shunt ampere turns, + the 720 of the 9 series turns + the armature ampere turns, 5750—twice the ampere turns between the double angle of lead, $2 \times (.3 \times 5750)$, or $3400 = 8670$ which will produce a magnetic density through an air gap of 2.64 cms. depth of

$$\frac{8670 \times 1.26}{2.64} = 4100,$$

while the actual magnetic density measured at this point was 3950, an agreement within the possible limit of error.

In Fig. 10 are given curves showing the magnetic performance of an armature, with its conductors laid in deep, narrow grooves, as shown in Fig. 12. The clearance on each side was one-sixteenth of an inch, making the double air gap one-eighth of an inch. Additional dimensions are as follows:

Diameter of the armature core..................	6. in.
Length of armature core..................	6. in.
Resistance of armature..................	.34

1. A paper read before the American Institute of Electrical Engineers, New York, September 23d, 1891.

Number of sections	64.
Turns per section	3.
Output, amperes	20.
" volts	100.
Speed	1800.

Curve 1, in Fig. 10, shows the distribution of magnetization at 112 volts, no current, a speed of 1800, and a field excitation of 2600 ampere turns. Curve II. shows the magnetic distribution for an output of 97 volts and 24 amperes, at a speed 1800, and a field excitation of 2,600 ampere turns. Curve III shows the magnetic distribution at an output of 40 volts and 20 amperes, at a speed of 1800, with a field excitation of 750 ampere turns. This same excitation when the armature furnished no current, produced an E. M. F. of 48 volts, at a speed of 1800 revolutions. The poles were shaped as in Figs. 11 and 12, but modified as explained below. In making these experiments carbon brushes were used,

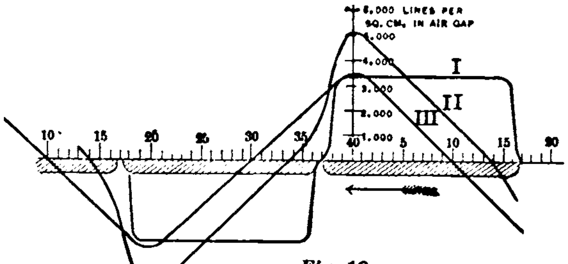


Fig. 10.

and their position maintained at the normal diameter of commutation. An average magnetic density in the air gap of 8400 lines per sq. cm. was required to produce an E. M. F. of 112 volts. The grooves on the armature in which the conductors were placed occupied one-half of the armature surface, so that the actual magnetic density in the air gap was 1.8 times this average magnetic density. The ampere turns required to set up this magnetic density in the air gap were

$$\frac{.125 \times 2.54 \times [3400 \times 1.8]}{1.26} = 1520,$$

which is the number of field ampere turns whose magnetizing force is impressed between the pole surfaces through the armature, when it furnishes 112 volts and no current. The ampere turns on the armature at a current of 24 amperes are

$$\frac{2 \times 64 \times 3 \times 12.}{2.} = 2300,$$

as against 1520 impressed by the field. Under these circumstances the magnetism under the weakened pole corners is reversed, as is also clearly indicated by curve II. in Fig. 10, or the curve C, E, D, F, C, in Fig. 11. This curve also shows that the magnetic density under the strong pole corners was 5,100 lines per sq. cm. Now in building this machine, six longitudinal slots, 1¼ inch deep, were cut in each pole immediately back of the surface, which enables us to be sure of the exact densities in the pole corners for a given distance. For a depth of 1¼ inches immediately back of the pole faces these slots took up one-half of the cross-section of the poles. Then a density, therefore, of 5,100, really means a density of 10,200 or a strong saturation for a distance of 2½ inches in the cast-iron of the poles. The magnetizing force required to produce 10,200 lines per sq. cm. through cast-iron is 200 per centimetre length. Therefore the ampere turns required to establish this density through 2½ inches are

$$\frac{2.5 \times 2.54 \times 200}{1.26} = 1,000.$$

The total number of ampere turns acting to produce magnetization through these strong pole corners was the sum of the field ampere turns that impressed magnetizing force from pole face to pole face through the armature, and the ampere turns on the armature covered by the poles. The poles covered approximately 85 per cent. of the armature surface, making this value: $1500 \times [2300 \times .85] = 3400$. Of this number, as was just shown, 1,000 were utilized in producing the magnetic density of 5,100, through the saturated portion of the poles The remaining 2,400 ampere turns exerted their magnetizing force in producing the average magnetic density of 5,100 through the air gap, and affords another opportunity of checking these ideas of the action of the armature on the field. For the ampere turns required to set up an average magnetic density of 5,100, through the air gap under consideration were:

$$\frac{[1.8 \times 5100] \times .125 \times 2.54}{1.26} = 2300,$$

which checks with the above value as well as could be expected. When the armature furnished 24 amperes, the E. M. F. at the brushes was 97 volts, while with no current it was 112 volts. Of this drop of 15 volts, 8 are accounted for by the resistance of the armature, and the extra seven were caused by the saturated pole corners. By operating this same machine at an E. M. F. at which the pole corners could not saturate with normal output of current, we have demonstrated for us in a very striking manner that the armature ampere turns cannot change the total magnetization established through the armature by the field when the pole corners do not saturate. The E. M. F. with the armature current at zero was brought to 48 volts with a separate field excitation of 750 ampere turns. Then when the armature was allowed to furnish 20 amperes the E. M. F. at the brushes dropped to 40 volts. Of this drop of 8 volts, 7 were produced by the resistance of the armature. Yet the field is powerfully distorted by the armature current, as may be seen by reference to curve III., Fig. 10, or the curve A, D, C, B in Fig 12. Even with this very great rearrangement of the magnetization produced by the armature current, the total magnetization set up by the field is practically unchanged. The difference of potential on the commutator between the points A. B., Fig. 12, was observed to be 72 volts. This excess of E. M. F. over that which was produced at the brushes, the figure shows clearly to be due to the magnetization produced by the armature through itself and the strengthened pole corners. The points where the field is zero are at A. B. They mark the diameter through which the ampere turns encountered on the armature are just equal and opposite in action to the ampere turns of the field that impress a magnetizing force between the pole faces through the armature. A simple computation will show that this is true. The field ampere turns that impress magnetizing force between the poles when the armature produced an external E. M. F. of 48 volts are

$$\frac{1520 \times 48}{112} = 650.$$

The ampere turns on the armature opposed to the magnetization set up by the route A. B. are $\frac{12}{40}$ of the total number of ampere turns on the armature [see Fig 12,] or

$$\frac{12 \times 64 \times 3 \times 20}{40 \times 2} = 576$$

This is a fair agreement when we consider the accuracy with which the original data may be determined.

Mr. Esson in his valuable paper, aboved referred to, discussed the requisite features for a generator for constant current, with closed coil armatures, in which regulation is effected by shifting the brushes. He stated that the field should be uniform at all points, under the poles, and that the armature core should be saturated. These statements are a little misleading. The magnetizing force impressed by the field ampere turns must be uniform at all points between the pole faces. This is accomplished by proportioning the poles so that the strongly magnetized pole-corners will not become saturated when the brushes have their

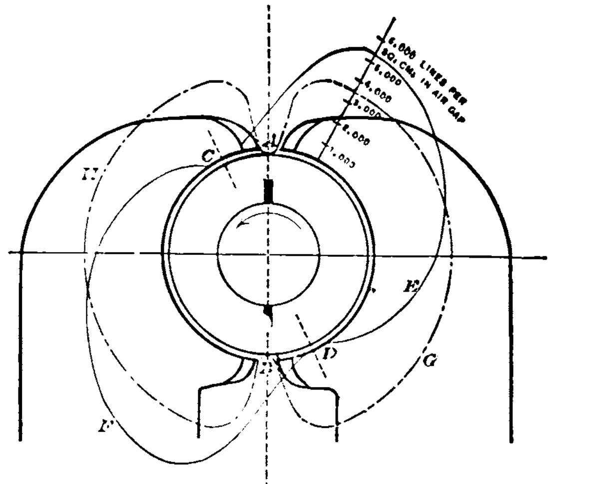


Fig. 11.

extreme position for the development of the highest E. M. F. that the machine is to produce. The air gap is made of such a depth that the ampere turns required to set up the magnetization through the armature, without current, and for the production of the highest E. M. F. that the machine will be called on to give, shall be a little more than the armature ampere turns when it furnishes its normal current. Then as long as the brushes are kept under the pole-faces, the non-sparking point will be whereever the brushes are placed. This will be the case whether the armature is or is not saturated. A practical demonstration is found in the following experiment: A Siemens & Halske dynamo with magnet and armature cores, whose shape and dimensions are shown in Fig. 5, was used.

Length of armature core	7.25 in.
Number of armature sections	56.
Turns per section	6.
Revolutions	1000.
Output in volts	50.
" " amperes	30.

The field was separately excited with 4000 ampere turns on each of the sets of consequent poles. Regulation could then be effected for a constant current in the armature of 22 amperes, by shifting the brushes from no E. M. F. to 35 volts without the slightest sparking even when metallic brushes were used. Within this limit the pole corners did not saturate. The field cores were wrought and the yokes cast iron. When the armature circuit was broken, it was found that the field excitation of 4000 ampere turns produced an E. M. F. of 50 volts. The magnetic density in the field cores, including leakage, was only 11,000 lines per sq. cm. Therefore, of the 4000 ampere turns on the field, not more than 200 were applied in setting up the magnetization from pole face to pole face through the field cores. It is safe to assume, then, that of these 4000 ampere turns, 3800 were active in producing a magnetizing force impressed uniformly over the pole faces through the armature. This same value is obtained by the method adopted in the previous cases. That is by calculating the magnetic density in the air gap when 50 volts were developed, and then deducing the number of ampere turns required to

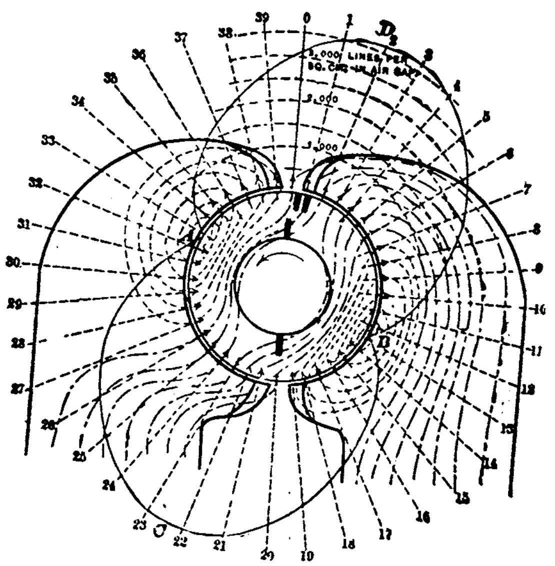


Fig. 12.

establish such a magnetic density through a 1¼ inch air gap. As to the armature, when it produced 22 amperes its ampere turns numbered

$$\frac{2 \times 56 \times 6 \times 11}{2} = 3700,$$

or an excess of 100 ampere turns impressed by the field over and above those on the armature. As long as this same number of ampere turns was maintained on the field it was not possible to regulate for a constant current of a lower or a higher strength without sparking. The impressed field ampere turns are in excess of the armature ampere turns by that amount which is just sufficient to produce a weak positive field that will reverse the current in the coil when its terminal bars at the commutator pass under the brush. When regulation is effected by this means it is seen that all pole corners are alike magnetized and at the centre of the pole faces the magnetization is zero when the machine is short-circuited. At full output, at the highest E. M. F., the magnetization under the one set of pole corners is almost zero, and under the other set it is at the maximum value that is ever obtained. In a generator of this type when the poles are made stout enough at all points, the total amount of magnetization through the armature, at all loads, will remain at a constant value. When used for operating long arc lamps a "drooping characteristic" can better be obtained by saturated field cores than by saturated pole-corners and armature core.

What has been said of dynamos applies equally well to motors. The only difference is that the non-sparking points are on opposite sides of the diameter at which magnetization is zero in the air gap. This is due to a well-known cause. In a motor the armature rotates in an opposite direction when field and armature currents remain the same as in a dynamo. The E. M. F. of self-induction caused by the reversal of the current in a current has not changed, while the E. M. F. developed in the coil by the field has changed sign with the change of the direction of rotation. The result is that the reversal of the current in an armature section must take place in a weak field of an opposite sign in a motor from what it does in a dynamo, when sparking is to be avoided entirely.

The action of the current in the armatures of multipolar dynamos and motors will be the same as that found for two pole machines.

[In view of the importance of the subject treated in this paper, it was voted, on motion of Mr. J. Stanford Brown, that its discussion be continued at a future meeting. Members who may not be able to attend and who are interested in the matter are requested to send to R. W. Pope, secretary, 12 West 61st street, any communications which they may wish to have incorporated in the discussion.]

FAURE'S NEW CARBONATE OF IRON BATTERY.[1]

THE new carbonate of iron battery of M. Camille A. Faure is composed of wooden troughs, say, about 27 ft. long, by three ft. nine in. high and six ft. six in. wide, enclosing some hundred or so double electrodes six ft. six in. wide. These electrodes are constituted of an agglomerate of carbon obtained by grinding up in a mill, drying, and then carbonizing at 1,400 deg. C., a paste composed of quarter by weight of oats, quarter of bituminous coal, and half of very porous, clayey earth. An agglomerate is thus obtained which is extremely porous, with which one side of the electrodes only is covered, the other receiving a coating of tar, rendered entirely impermeable by rebaking. The porous side of the electrode is covered with a large piece of netting or coarse sailcloth. The space between these double electrodes is filled in with granulated iron. The liquid used is salt water led in by tubes. The current is taken from two iron plates at the two extremities; the space between one of the plates and the last electrode is filled in with coke or copper turnings of a sufficient conductivity to carry the current of 1,000 amperes, generated by this battery at a tension of about 1.15 volts.

The elements of iron and carbon immersed in salt water (NaCl) produce chlorate of iron, caustic soda, and hydrogen, with an E. M. F. of about .30 volt; the hydrogen recombining with the oxygen increases this by .40 volt; and the carbonization of the soda by the carbonate of iron adds another .30 volt, which is again increased .15 volt by the use of reduced porous iron instead of solid iron. Thus the total E. M. F., according to M. Faure, is .30 + .40 + .30 + .15 = 1.15 volt.

In the electrolytic reaction the carbonate of iron and the chlorate of iron form carbonate of iron and chlorate of sodium, which is thus regenerated; the battery only uses the iron transformed into carbonate, which, as will be seen, is easily regenerated, as well as the carbonic acid used for this regeneration. The cloth-covered porous surfaces constitute the positive faces of the electrodes; they are depolarized by the gases, which penetrate between the faces of each double electrode, which are arranged in cone shape, by holes placed in the bases of this cone, and of which the inert part—the nitrogen—escapes by the porous face, at the same time agitating the liquid. The reduction of the carbonate of iron takes place in a retort charged with carbonate of iron, and traversed from top to bottom by gas reducers—CO, H, etc.—coming from a gasogene. Passing from the retort, these gases take fire at the contact of air, forming carbonic acid, which passes around the retort to the chimney, whence a portion of the gas is drawn by a pump, which forces it, after washing, into the battery. The air necessary for the combustion of the gasogene arrives, already heated, by a chimney, and the reduced spongy iron passes away cold by a channel placed at the base.

The installation of a Faure primary battery comprises, therefore, besides the battery properly so-called—(1,000 elements)—a pump capable of forcing 1,000 cubic metres of carbonic acid per hour, a machine to agglomerate the carbonate of iron passed out of the channels, into bricks, and the reducing chamber. According to M. Faure, the consumption of fuel in the retort is not more than 0.3 lb. of coal per pound of iron used in the battery, or per h. p. hour at the battery terminals.

ELECTRICAL HEATING.

WE are glad to learn that there will be a complete exhibit of the Burton electric heaters at the Street Railway Convention in Pittsburgh, and also that Dr. W. Leigh Burton, the inventor, will be present, a circumstance which will certainly add largely to the interest of the exhibit. This will be an occasion for street railway men to examine the heaters personally and to determine the comparative value and economy of electric and other heaters. Electric heating, as electric lighting, is of universal interest, and having received its first successful employment upon electric cars, must necessarily be of deep interest to all street railway men.

1. *Bulletin de l'Electricité.*

THE SHORT RAILWAY MOTORS.

OUR readers will recall a description in THE ELECTRICAL ENGINEER, of April 1, 1891, of the Short "gearless" railway motor, then brought before the public for the first time. In view of the improvements already made upon this motor, and the favor with which it has been received, a further account cannot fail to be of interest.

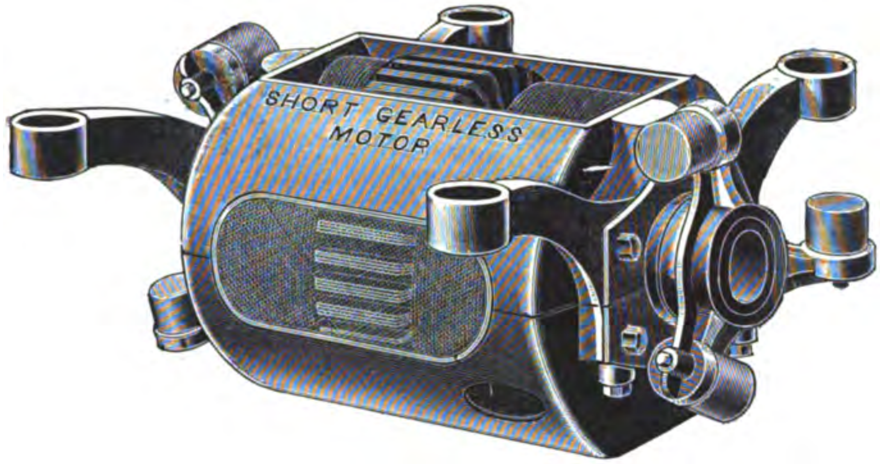


FIG. 1.—SHORT GEARLESS MOTOR.

The motor is shown in Fig. 1 of the accompanying illustrations. As will be seen, all gearing is eliminated from the machine, and the number of bearings is reduced to two on each motor, making four in a car equipment. The armature speed has been reduced to the minimum, viz., that of the car axles in practical operation. The noise of gearing and the "squealing" of commutator brushes are entirely obviated, and there are but three wearing parts on each motor. The armature is of the ring type, of comparatively large diameter and increased "leverage." It is keyed to the hollow steel shaft, which is concentric with the axle of the truck, and an inside clearance of one inch all around is provided for. The coils of the armature are, in this, as in all Short machines, entirely independent and perfectly ventilated. The motor has eight field magnets, four on each side of the armature. They face each other at a distance of only ten inches, and thus form a most intense magnetic field. They are bolted to the frame-work of the motor, in the centre of which are the bearings which carry the hollow armature shaft.

Mounted upon the hollow shaft close to the armature is the commutator, which is protected from injury by the surrounding pole-pieces It is massive in construction, and much larger than any commutator heretofore used, the idea being that, because of its massiveness and slow speed, the wear would be reduced to a minimum. Six months' operation of these motors has proved the correctness of this idea and disclosed other distinct advantages in the use of the enlarged commutator.

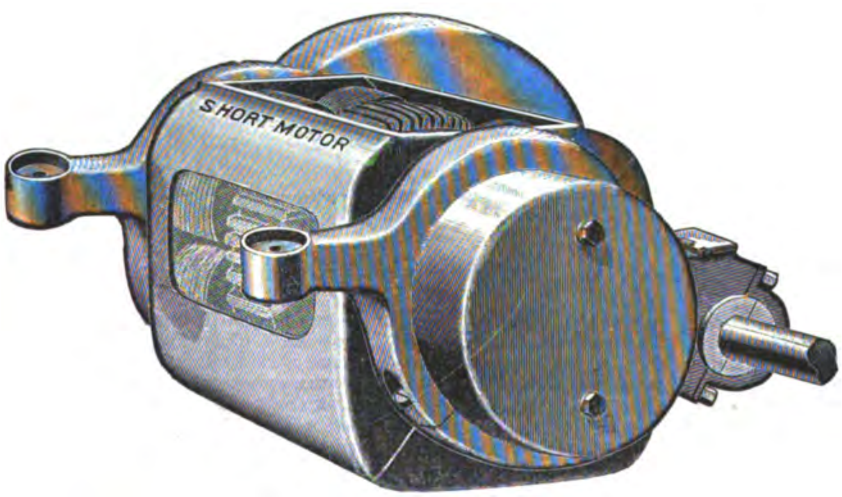


FIG. 3.—SHORT SINGLE-REDUCTION MOTOR.

A glance at Fig. 1 will show the method of mounting this simple machine. A three-armed spider is placed upon each end of the hollow shaft. Each arm is provided at the extremity with a socket to receive a rubber cushion or spring. These cushions bear upon lugs cast on the car wheels, and as the armature shaft and spider revolve the action is imparted to the car wheels. This rubber cushion serves the double purpose of insulation and easy starting.

The electrical output of the motor has been noted with great interest, and all tests have been carefully tabulated. The following result has been obtained from thousands of readings taken on the three electric railway lines in Cleveland:

Average volts.	Amperes.	E. H. P.	Passengers.
480	24	15.44	48

Fig. 2 shows the Short Standard "Double-Reduction" or geared motor, which is already familiar to our readers.

The "Single-Reduction" or "Water-Tight" motor is shown in Fig. 3. One pinion and one gear have been dispensed with, and arrangements made to run the remaining gear in oil. The machines are practically the same, and a series of efficiency tests show that in economy of current and in output of power there is little choice between them. The "W. T." motor however, is smaller than the "Standard" motor, and, it is claimed, is the lightest and smallest street car motor thus far constructed. It weighs something less than 1,800 pounds. It is encased in, and entirely protected by, its iron frame, and can be operated on 30 inch, 33 inch and 36 inch wheels, and on any gauge of track down to 3 feet. It is in great demand for narrow-gauge roads and for mining and other electrical haulage purposes. It is made in two standard sizes, 15 and 20 h. p.

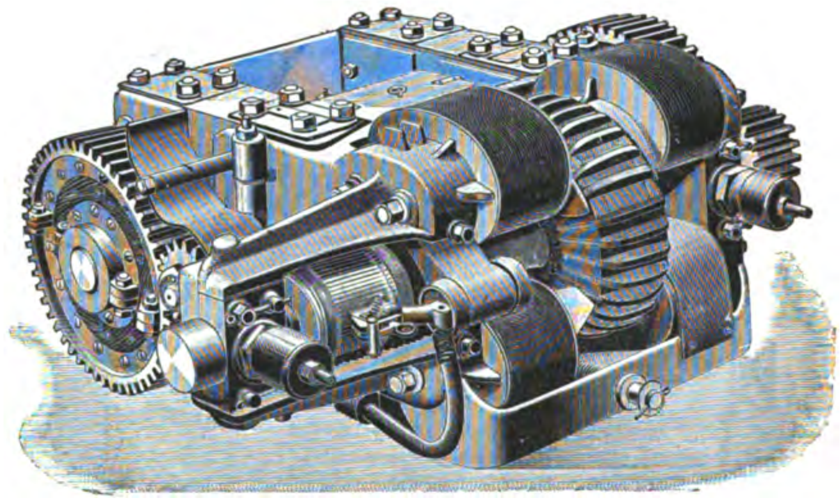


FIG. 2.—SHORT STANDARD MOTOR.

Carefully kept records of the operation of electric cars on the many roads equipped with Short geared motors show that the cost per car mile ranges from two to four mills.

The Jamestown, N. Y., Street Railway operated ten Short cars from June 10 to August 29, a period of 11 weeks, with a total loss of but two car days. On the Rochester, N. Y., Railway, during eight months of operation, the total cost of repairs, including material and repairs to electrical machinery was but four mills per car mile, and the average loss per car was but 4 per cent. of the total mileage.

SOME BIG SCHIEREN BELTS.

ANENT recent statements as to the biggest big belts Charles A. Schieren & Co. write us: "Last spring we supplied the Louisiana Electric Light Co., New Orleans, La., with 160 feet of 72-inch double leather belting ½-inch thick, and up to that time it was the largest belt in the world. Last March we supplied the Tacoma, Wash., Railway & Motor Co. with 158 feet of 54-inch perforated electric leather belting, three ply, ¾ inch thick. We have just supplied the Botany Worsted Mills, Passaic, N. J., with two 60-inch three-ply leather belts, 145 feet long each. We have also just made three 54-inch double leather belts 112 feet long each, for the Denver, Col., Electric Co.; also 150 feet of 50-inch double perforated electric leather belting for the Madison Car Works, Madison, Ill., and 145 feet of 60-inch three ply leather belting to the New

York Biscuit Co., N. Y." These are a few of the company's large belts made recently. To one concern in the South they have shipped 548 feet of 48-inch double leather belting.

THE NEW TRIPLE EXPANSION ENGINE OF THE LAKE ERIE ENGINEERING WORKS, BUFFALO, N. Y.

THIS engine is designed with a view to meeting the continually increasing demand for economy in floor space, in the use of steam, and thorough reliability. It is especially adapted for central station electric lighting and railway work, giving close regulation and economy, and occupying very little floor space, and is one of the first practical solutions of the problem of direct connection or direct bolting for the larger types of generators now being introduced in this country.

The rotative speed is chosen somewhat above the limitations imposed by the releasing valve gear of other engines, but is not what is called high-speed, the engine occupying middle ground in this particular. The pressures per square inch on the bearings, and the rubbing velocities of the journals, form the starting point in establishing the rotative speed, the rate of rotation varying in the different sizes of engines in inverse proportion to the diameters of their shafts; and the pressure per inch of bearing surface is kept below a certain limit in all sizes. This insures uniform results. The piston speed is universally 650 feet per minute, and the stroke is reckoned from the diameter of the shaft and its consequent rate of rotation.

The accompanying illustrations, Figs. 1, 2, and 3, are from scale drawings of triple-expansion engines, and are shown connected directly to two 500 h. p. electric generators. They are intended to work under from 140 pounds to 160 pounds steam pressure when connected with condensers, and from 180 pounds to 200 pounds steam when exhausting into the atmosphere. Their rated power is 1,000 h. p. when most economically loaded, but they are capable of performing 1,200 h. p. or more very easily should they be called on to do so.

It is expected to obtain as good economy with these engines working under from 130 pounds to 200 pounds steam pressure without condensers as with best compound condensing engines under from 30 to 100 pounds of steam. Their adaptability, therefore, to situations where water cannot be obtained for condensation is apparent. It is said that by using triple-expansion engines thoroughly adapted for the service under heavy steam pressure without condensers, not more than one-half the fuel now commonly used will be required.

Figs. 1 and 2 are front and side views of the three-cylinder type; it will be seen that each cylinder acts through an independent set of cranks on a common crank shaft; this is 9¾ inches in diameter, carries at each end an armature, and has two intermediate wheels. In this manner the weight is distributed evenly

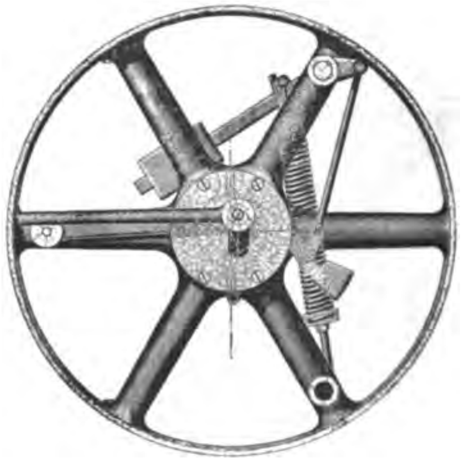
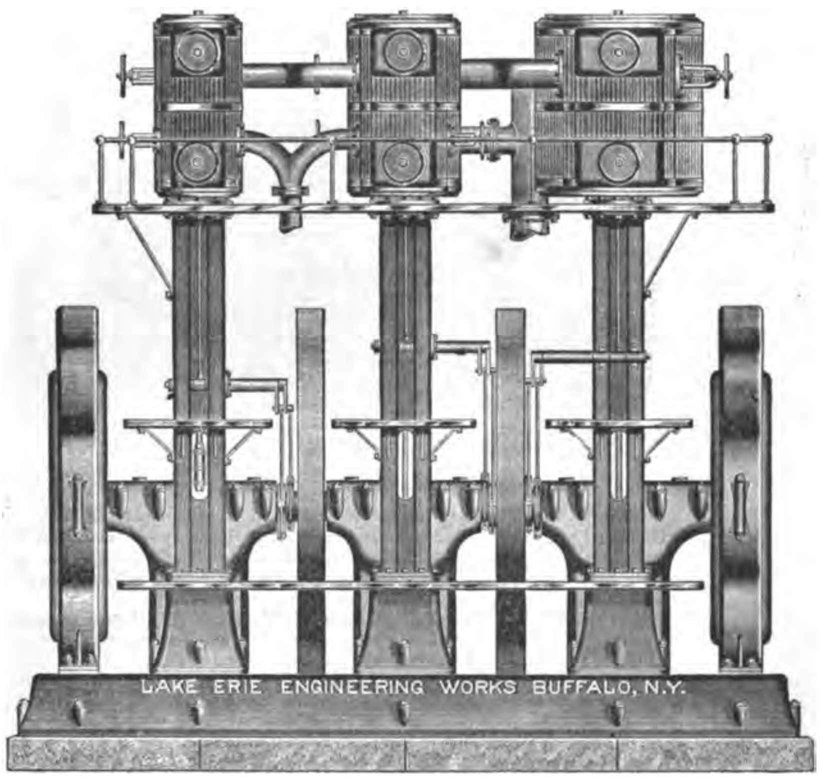
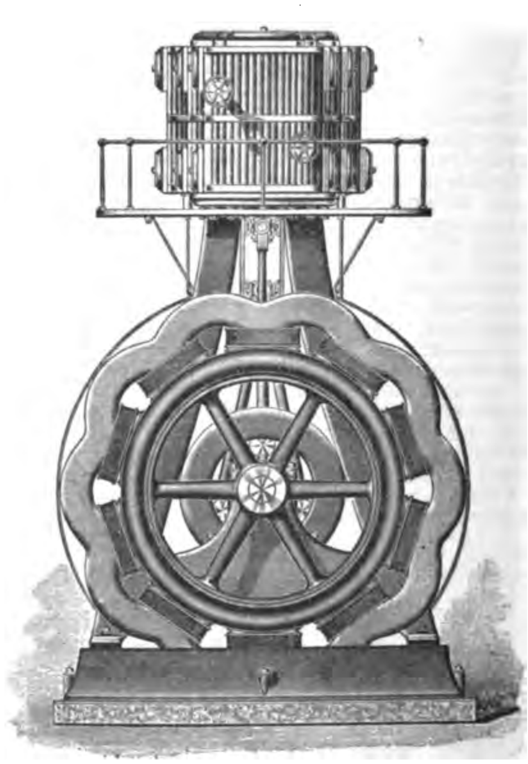


FIG. 3.

along the shaft upon bearings, tending to bring equal wear upon each journal along its length, and in this manner keeping the shaft straight and free from undue strains.

Each cylinder has an independent framing and pedestal, the whole including the generators standing on a common bed-plate. The columns are "divided," allowing sufficient space between the divided halves for the valve stems and rock arms of the high-prussure and intermediate pressure cylinders, bringing the valve chests at right angles to the crank shaft, where they are perfectly easy of access. These valve chests form the receivers between the cylinders. Four valves are used on each cylinder, the steam and exhaust being independent of each other, and the steam lap and exhaust lap adjustable, so that the admission, lead, closing and opening of exhaust or point of cut-off may be easily altered by adjustment. In this manner the engine is easily adapted to any service, either condensing or non-condensing. In addition to this, the point of cut-off may be changed by hand for the low-pressure cylinders while running, so as to afford that refinement





FIGS. 1 AND 2.—LAKE ERIE ENGINEERING WORKS TRIPLE-EXPANSION ENGINE.

in the management of the receiver pressures required for exceptional economy in the use of steam.

The clearances are small, averaging from 2¼ to 6 per cent. according to sizes of cylinders, and the valves are adjusted to fill the clearance by compression, neutralizing the small loss that would occur in these limited clearance spaces, and at the same time insuring against "knocking" on the rod bearings and main journals.

The valves are four-ported, and therefore small and light, flat-faced and nearly balanced. They press against their seats just sufficiently to keep tight, and are allowed to follow their wear. The engines are of the disconnective type.

By the use of the four valves above mentioned, the engine can be converted into either a small compound engine, by disconnecting the low-pressure cylinder. or it may be made into a large compound by disconnecting the high-pressure cylinder, and the change can be made while the engine is running, the governor being connected to the intermediate steam valves when using the intermediate and low pressure cylinders as a compound. By this arrangement but one governor is used, and its action can be thrown on to the intermediate steam valves either in full or in part, as desired. The main bearings are provided with babbitt-lined shells, and are water-jacketed, a water-jacket being provided in the back of the guides also. The engines are equipped with complete apparatus for grease lubrication. The cranks and shafts are forged and of the built-up pattern, with counterweighted crank arms.

The governor is illustrated in Fig. 3. A similar governor is placed in one of the intermediate wheels in the triple engine shown. The Lake Erie Engineering Works are equipped to build these engines in sizes from 150 h. p. to 10,000 h. p.

The Field Engineering Co., of New York, who are making a specialty of large power station construction, and have built a number of representative stations for railway and lighting work, and who have been looking for an engine which would best fill the requirements of their practice, have concluded arrangements to specially represent this engine in their line of work. They are having the Lake Erie Engineering Works build two large engines of this type, in two cylinder compound, soon to be installed in the power station ofthe Buffalo Railway Co.

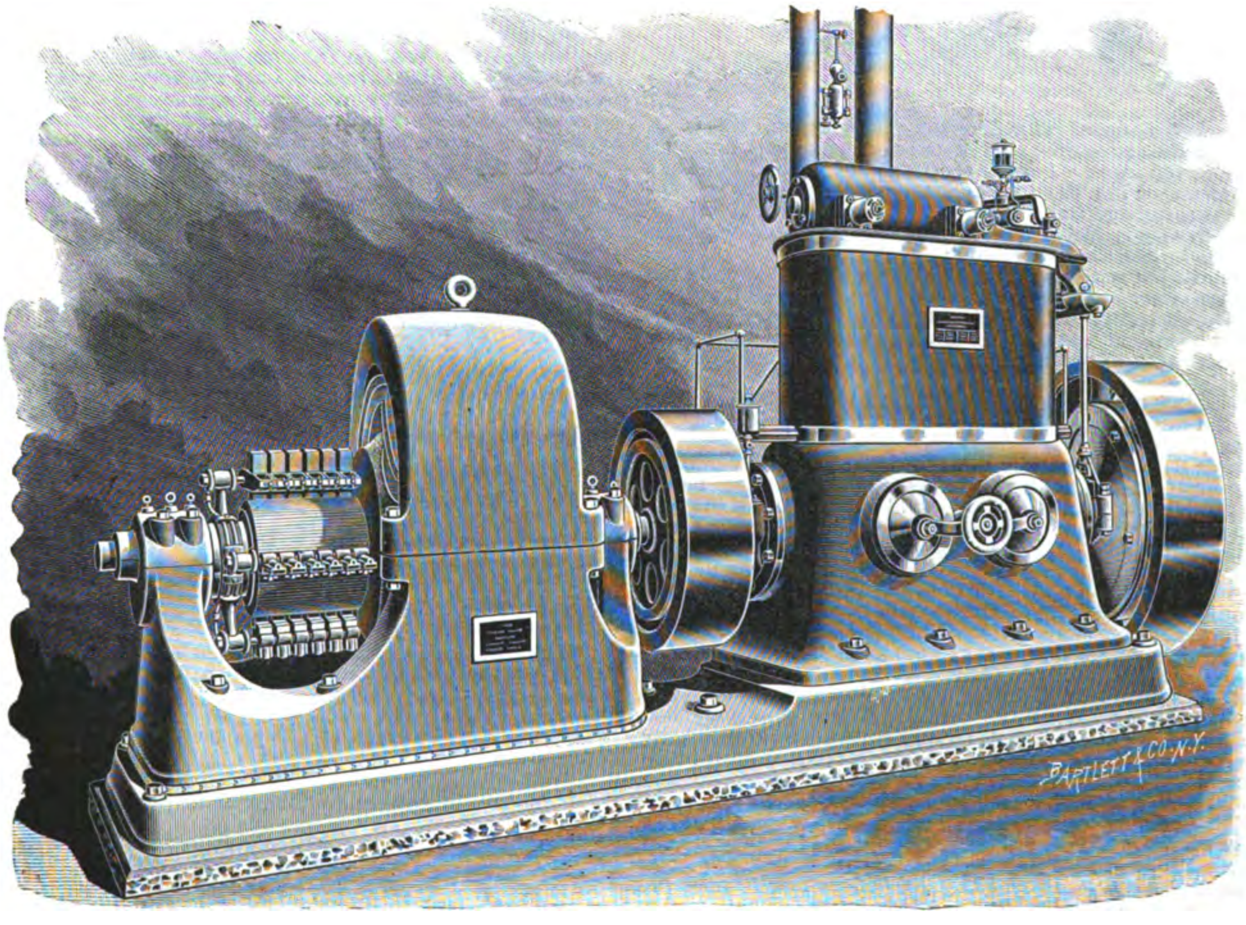
MR. E. W. GOSS has entered upon his duties as superintendent of the Electric Light Co., Amesbury, Mass.

WESTINGHOUSE DIRECT-COUPLED MULTIPOLAR GENERATOR.

THERE is little room for doubt that the generating plant of the future, so immediate as to be almost the present, is to be the direct-coupled, slow-speed, multipolar generator for electric railway stations, and the same system in connection with a dynamo for electric lighting. The advantages are sufficiently apparent. The first cost of a plant on this principle, as compared with a system involving counter-shafting, clutch pulleys, belt tighteners, belts, etc., is enormously in its favor. This is obvious when referring to the machinery alone, but is strongly emphasized when the further value of the reduced cost of real estate and buildings is considered.

Again, every transformation or transmission of energy is a loss of money, and it follows that when the crank shaft of the engine is the armature shaft of the dynamo the loss is reduced to its lowest terms.

Next to the direct saving in power comes the saving in space. As a general statement, fully twice as much generating capacity, with the same accessibility and convenience, can be got into a given floor space with the coupled dynamo as with the direct-belted generator, and from four to eight times as much as with indirect belting through counter-shafting.



WESTINGHOUSE DIRECT-COUPLED MULTIPOLAR GENERATOR AND COMPOUND ENGINE.

In the item of attendance and maintenance the coupled generator possesses manifest advantages in eliminating the belt account wholly, and the oil and babbitt account in large part. Not the least of the recommendations of the coupled generator is that it is strictly noiseless.

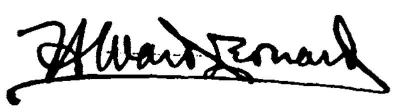
Recognizing the demand for this form of generator and the certainty of its permanent success, Messrs. Westinghouse, Church, Kerr & Co. have, in connection with the Westinghouse Electric and Manufacturing Co., developed it in the form as indicated in the accompanying engraving. The engaving represents a 250 h. p. generator for railway work coupled to a compound engine capable of developing 250 h. p. at 100 lbs. pressure of steam, non-condensing, the speed being 250 revolutions. The design is that of a single machine carried upon a massive bed-plate requiring only moderate foundation. The generator is thoroughly insulated from the bed-plate by a sheeting of tarred plank, the bolts being insulated by bushings and washers of non-conducting material. The insulation is completed at the coupling, in which non-conducting material is interposed to prevent metallic contact. The coupling is further so designed that it will yield fully to any misalignment of the two shafts either as to angle or position of centres. The larger engines are provided with unhooking gear in the valve motion so that they can be handled by a starting bar, and are also fitted with a gallery sole-plate and stairway protected by handrails, so that the throttle valve and lubricator are conveniently accessible.

The same general design is carried out for direct coupling to heavy alternating dynamos. The sizes at present manufactured correspond to 125, 250 and 500 h. p., with 1,000 h. p. to follow. The sizes of engines required for the given power will vary according to the steam pressure carried; 180 lbs. being contemplated as a maximum, and 100 lbs. as a minimum.

The same company has also completed the preliminary work of a design for a third high-pressure cylinder for converting the compound engine into triple expansion.

MINIMUM FIRST COST OF PLANT AND MAXIMUM ECONOMY OF OPERATION IN THE ELECTRICAL TRANSMISSION OF POWER.

BY



In the last issue of THE ELECTRICAL ENGINEER, Mr. C. J. Reed, under the above title, argues that my deductions are radically wrong and says: "I again challenge Mr. Leonard, through the indulgence of THE ELECTRICAL ENGINEER, to show his proofs."

It is not surprising that Mr. Reed feels confident that my results are all wrong, for he claims to have discovered a radical error which he describes as follows:

"He starts out with an arithmetical error and in his reply adheres to the error, insisting that it is correct. I will call his attention to it specifically. In his expression for the weight of the conductor he uses M, the area of 2 D as a factor, and then introduces the factor "2" again giving the weight of a conductor 4 D in length."

I find it difficult to be more explicit than I have been on this point. But perhaps the following statement may point out Mr. Reed's error clearly.

Formula (1) determines the cross-section of the conductor in circular mils. In order to get this cross-section it became necessary to consider the resistance of the total length (2 D) of the conductor both outgoing and returning; this introduces the factor 2 D for the first time. Having now obtained the cross-section M of the conductor, we next get its weight per foot, and then to get the weight of the total length of conductor both ways we must again multiply by 2 D. This introduces 2 D for the second time.

If I have not now made it clear that formula (2) is correct and not 100 per cent. out of the way, I would suggest that the reader, by other formulae available, determine the cross-section and weight for any assumed conditions, and compare the result with that obtained by my formula. A few practical applications will oftentimes change one's views materially and enable one to see exactly the correct application of a formula apparently likely to give incorrect conclusions. If Mr. Reed or any one else interested will take the trouble, after assuming a set of conditions, to get the minimum first cost by gradual approximation he will find that the formulæ given by me are entirely correct. The formulæ are not the result of an abstruse mathematical research, but are exact expressions of conditions which become evident to any one who daily has to deal with estimates in which large sums of money depend upon determining the best possible conditions for operation. I cannot demonstrate the accuracy of the formulæ mathematically any more perfectly than I did in my original article, which led the reader step by step to the conclusion. Hence, I shall not bore your readers with mathematical expressions which can add nothing to the proof.

Mr. Reed cannot understand how it is possible that the conditions of minimum first cost are such that an increased cost of conductor is necessitated by conditions demanding an increased loss. He says of this,—"an absurdity so obvious that it is unworthy of discussion." If Mr. Reed will consider a transmission of say 30,000 feet, with dynamo machinery at $33 per kilowatt at brushes and copper at 20 cents per pound, he will find that with 3,000 volts initial E. M. F. he must, for minimum first cost, operate with 21.5 per cent. loss in conductors and that the cost of conductors will be $15.81 per kilowatt at motor brushes. If he operates with 2,400 volts initial E. M. F. he must, for minimum first cost, have a loss of 25 per cent. in conductor and the cost of conductor will be $22 per kilowatt.

Stated as above, I think Mr. Reed will admit that it is not surprising that my formulæ (12) and (13) show that the conditions which make a minimum first cost with 25 per cent. are such that the cost of conductors will be then more than the cost will be when the conditions are such that 21.5 per cent. gives minimum first cost. I will emphasize again the importance of remembering that we are not discussing the conditions which prevail for *any* loss in conductors, but should confine our attention to the conditions which make minimum first cost for any given set of values.

Mr. Reed has apparently been unable to rid his mind of the impression that under all circumstances an increased percentage of loss in conductors must mean a decreased cost of conductors, which, as is shown by the instance above cited, is not always so, and is never so under conditions of minimum first cost.

Another point which Mr. Reed will not admit is that the condititions of minimum first cost are such that the cost of conductors depend only upon the loss and the cost of dynamo machinery. Yet this is entirely true. If dynamo machinery is worth $33 per kilowatt and copper 20 cents per pound, the conditions making it possible to realize minimum first cost with 21.5 per cent. are such that the cost of copper will be $15.81. This applies to any E. M. F. and distance which make a minimum first cost possible at 21.5 per cent. loss. Also, if our conductors be worth twice as much as before, we will find that the only conditions making it possible to realize a minimum first cost at 21.5 per cent. are those in which the cost of dynamo machinery is also doubled, that is, $66 per kilowatt. In other words, conditions of minimum first cost are such that the cost of conductors depends only upon the percentage of loss and the cost of dynamo and machinery.

Mr. Reed has pointed out that the example I cited to show the inaccuracy of Sir William Thomson's law was not a commercial one. This I admit, but that does not affect the accuracy of the conclusion. I will, however, give a commercial example:

Suppose interest and depreciation to be 15 per cent. and the value of 1 kilowatt per annum as used to be $20, also that we are using 100 volts per 1,000 feet. It will be found (as is shown by my chart No. 3) that the interest and depreciation equals the value of the energy wasted when we lose 31 per cent. in conductors. By Sir Wm. Thomson's law we would then be operating at maximum economy. But we find that in reality we should operate at 12 per cent. loss in conductors, for then we would have an interest and depreciation charge of $9.60 and a value of energy wasted of $2.50, a total of $12.10, against a total of $9 plus $9 or $18, by following Sir Wm. Thomson's law.

I trust that if further criticism regarding my deductions be offered, that practical conditions will be assumed and the resulting figures will be quoted, as I feel that no special gain can be made by merely theoretical discussions of formulæ so easily misinterpreted as those pertaining to this subject are.

Reports of Companies.

TROPICAL AMERICAN TELEPHONE CO.

GENERAL MANAGER HOWARD says the Tropical-American Telephone Company is turning its ready capital about three times a year at a fair profit; that it is enlarging its field and extending its business month by month. The sales for August were over $14,000, and sales in 1890 were 50 per cent. over sales in 1889.

THOMSON-HOUSTON ELECTRIC CO.

THE trustees of Thomson-Houston trust securities, series D, will make a division of the funds in their custody Oct. 10, 1891, by the payment of $1 per share to shareholders of record Oct. 3, 1891. The transfer books will be closed from Oct. 5 to Oct. 10, 1891, both days inclusive. The rush of business at the Thomson-Houston works is caused in part by the established roads giving orders for increased equipment.

EUROPEAN ELECTRIC WELDING CO.

THE European Electric Welding Company has mail advices that at the offering of the stock of the English company, 16,668 shares were sold, and that the English company is prepared to pay the balance of £15,000 due the European company upon transfer of the property. Counsel is preparing to make the transfer. Completion of the deal will give the European company about $425,000 cash, and a dividend upon its $1,500,000 capital will be in order. The European company gave German parties an option on the patents for northern Europe, which lapsed last week; nevertheless, an agent will soon be sent to Germany and another to France, with a view to sell the patents for the territory embraced if satisfactory terms can be secured. The European company can soon pay $20 to $25 per share on its stock if the directors so elect.

Appointments, Etc.

MR. A. H. LYNCH, who has for some time been the superintendent of the Willimantic Electric Light Co.'s plant, has gone to Hartford, where he will take charge of the work of putting in plants of the Waterhouse system.

MR. A. H. BURNETT, who has been superintendent of the Somerville Electric Light Co. for about two years, has resigned, and Mr. J. G. Raymond has succeeded him. Mr. Burnett goes to New Hampton, N. J.

MR. M. J. KEENAN has assumed the office of superintendent of the Galveston City Railroad Co.

MR. HIRAM TERWILLIGER has been made superintendent of the electric light works at Nashville, Tenn.

Literature.

PERIODICALS.

The Engineering Magazine, (World Building, New York City), for October, is very interesting to electrical engineers. One of the articles, on the Keely motor, is by Mr. T. Carpenter Smith, M. E., who is well known in electrical circles. Another article, by Mr. H. Ward Leonard, on Block Signaling, is quoted extensively in this issue of THE ELECTRICAL ENGINEER. A third article by Mr. N. G. Wall deals in an admirable manner with "The New Art, Decorative Electricity." As usual, the *Magazine* is well illustrated and printed, and an improvement has been made by putting the titles of the articles on the front cover in stronger type.

Harper's Weekly for Oct. 3 is quite electrical. It has an unusually able article by Mr. H. L. Webb, on the telephone service of New York, with many illustrations by Mr. H. Dearborn Gardiner. There is also an illustrated article on the electrical fountain in Lincoln Park, Chicago.

Society and Club Notes.

AMERICAN STREET RAILWAY ASSOCIATION.

THE tenth annual meeting of the American Street Railway Association will be held at the Monongahela House, Pittsburgh, Pa., Wednesday, October the 21st, 1891, at 10 o'clock, A. M., and continuing three days. The forthcoming meeting will, from present indications, be much more largely attended than any preceding. The following is a general programme of the meeting:

Reports of Committees.—Special committees will report on the following subjects: "A Perfect Electric Motor;" "A Year'-Progress of Cable Motive Power;" "Public and State Treatment of Corporations, No. 3;" "The Dependent—Overhead or Underground—System of Electric Motive Power," and "The Independent—Storage or Primary Battery—System of Electric Motive Power." Notice has been received by the secretary from the president of one of the member-companies that a special paper will be read, under the following title: "Standards in Machinery and Appliances for Electric Railways."

The Local Committee of Arrangements, of which John G. Holmes, Esq., president of the Citizen's Traction Company, is chairman, has chartered for the week of October 18th-25th a double decked excursion boat, which will be moored to the wharf alongside the Monongahela House, to be used for the exposition. Heavy supplies will be placed on the lower deck and lighter ones on the upper. The boat will be suitably decorated, and lighted in the evening, and will be made a pleasant and interesting place for the exhibition of supplies.

There will be various excursions, etc., and the convention will close with the usual banquet.

FRANKLIN EXPERIMENTAL CLUB, NEWARK, N. J.

THE Franklin Experimental Club, of Newark, held its first regular meeting since the summer vacation on Tuesday evening, Sept. 29th. There was a good attendance and every indication of an increased interest in the society and its work. The club is preparing to move into larger quarters, and, with a view of increasing the membership, it has decided to make the initiation fee for the next three months the small sum of five dollars. The dues are but one dollar and a half per month for active and associate members respectively; and each member is entitled to the use of any and all apparatus, books, papers, use of room by day or night, and other privileges of the society. Parties desiring further information may secure the same by addressing the secretary, Mr. F. W. Hillard, at 153 Mt. Pleasant avenue, Newark, N. J.

After the regular meeting on Tuesday evening, the members were entertained by some remarks by President Hammer upon the Convention and Exhibition of the National Election Light Association at Montreal. Following this, Prof. Geo. C. Sonn gave some interesting and entertaining accounts of his summer tour in Europe, where he visited the Electrical Exhibition at Frankfort. He also described many things of scientific interest which he saw in the large cities of England, France, Germany, Switzerland, Holland and elsewhere. His remarks were listened to with much interest.

NEW YORK TELEGRAPH CLUB.

MR. MARION KERNER, the well-known lecturer, and an equally well-known war telegrapher, is to deliver a lecture for the benefit of the above club, at Chickering Hall, at P. M., on Sunday, October 11, 1891, on the Ober-Ammergau Passion Play. This is one of Mr. Kerner's best illustrated lectures, and on this occasion he may certainly count on an enthusiastic and crowded audience. The music will be under the direction of Prof. Louis Berge.

THE ORDER OF RAILWAY TELEGRAPHERS.

THE Old Telegraphers' Brotherhood has now, it is understood, been practically absorbed by the Order of Railway Telegraphers. The plan has been proposed before, and was recently carried out at St. Louis. The final measures looking to union are expected to go through without delay or friction. The united body should be very strong and influential.

SOCIETY OF OPERATIVE ELECTRICIANS.

THE Boston Society of Operative Electricians, President W. S. Moody, has elected A. T. Chase, second vice-president, and E. Lundin and J. H. Hazlett additional members of the executive committee.

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

DR. HUTCHINSON AND MR. LEONARD.

MR. LEONARD'S reply to my paper scarcely calls for answer from me. Mr. Leonard merely repeats his former assertions, adding nothing new. For the present, I have only to say that I have added not an iota to Mr. Sprague's paper; mine was merely an attempt to put the matter in a slightly different view, so as to show directly, instead of by implication, where Mr. Leonard's error lay. Further, although it is a very natural assumption that I spoke for Mr. Sprague from the fact of my being with him in business, yet this is not the case; the views expressed were mine, and I only am responsible for them. Mr. Sprague is out of the city at present, owing to ill health, but on his return will doubtless speak for himself, should he deem it necessary.

CARY T. HUTCHINSON.

NEW YORK, Oct. 3, 1891.

Obituary.

HON. W. L. SCOTT.

FEW men have played so prominent a part in business affairs and in Democratic councils of late years as W. L. Scott, whose death at Newport has just been announced. He was interested in a great many enterprises, and was always ready to lend his aid in the development of valuable new ideas. It was thus that he became connected with the Eureka Tempered Copper Co., of North East, Pa. He was one of the directors of the company and was largely instrumental in enabling that concern to reach its present position and magnitude.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED SEPTEMBER 29, 1891.

Alarms and Signals :—

Electric Alarm, C. H. Shaffer, 460,287. Filed June 20, 1890.
A combined alarm and telephone service.

Automatic Electric Fire-Alarm System, W. S. Cook, M. C. Cook, A. H. Morrow, 460,464. Filed Oct. 18, 1890.
Has for its object to provide an automatic fire-alarm system which shall be at the same time extremely simple and perfectly reliable.

Electric Bell, W. Hay, 460,503. Filed May 11, 1891.
Has for its object a cheap and easy manufacture, installment and care of electric bells.

Electrical Railway Signaling Apparatus, W. F. Z. Desant, 460,524. Filed Sept. 26, 1890.
Improvement in railway block-signaling devices.

Electric Railway Signal, W. F. Z. Desant, 460,525. Filed Sept. 26, 1890.
Similar to 460,524.

Batteries :—

Electrode for Secondary Batteries, J. B. McDonald, 460,235. Filed Feb. 5, 1891.
Claim follows:
In a storage battery a grid for the support of the active material, composed of a metal ribbon having indentations or raised portions upon its surface and bent back and forth upon itself to form the supporting frame.

Distribution :—

System of Electrical Distribution, E. W. Rice, Jr., 460,364. Filed Feb. 18, 1891.
Relates to a novel system of multiple series distribution

Dynamos and Motors :—

Dynamo or Electric Motor, W. M. Fink, 460,125. Filed Oct. 7, 1890.
Has for its object cheapness of manufacture and economy of space.

Dynamo, W. H. Elkins, 460,372. Filed Nov. 28, 1890.
A dynamo containing considerably more turns on one coil than on the other; that having the greater number being connected to one of the main brushes and the other to an auxiliary brush, the coil of the other pole forming part of the main circuit.

Electrolysis :—

Apparatus for Electrolytically Separating Metals from Ores, W. von Siemens, 460,354. Filed June 18, 1890.
Claim 1 follows:
In an electrolytical cell the combination of a revolving cathode, a trough-shaped anode situated below the said cathode, in the trough of which the cathode revolves. A screen permitting the passage of the electrolyte and of electricity and capable of preventing the passage of vibrations of the electrolyte situated between the said cathodes and anode, and means for applying the electrolyte above the screen, and for withdrawing the oxydized liquid from the bottom of the trough of the anode.

Lamps and Appurtenances:—

Hanger for Incandescent Lamps, J. A. Matteson, 460,178. Filed Dec. 24, 1890.
Employs a counterpoise of such weight as to exactly balance the lamp when placed at any height.

Miscellaneous :

Electric Safety-Catch, J. W. Howell, 460,140. Filed Jan. 6, 1891.
Claim 1 follows:
A safety-catch for electric circuits composed of a conductor of electricity, which is destroyed by chemical action (as distinguished from fusion) when an abnormally large current passes through it.

Circuit-Controlling Apparatus, J. P. Cushing & W. J. Kelly, 460,199. Filed Nov. 6, 1890.
Relates to a switchboard designed for use in theatres, etc., whereby independent circuits may be readily and quickly connected.

Switch for Series Dynamo Electric Machines, C. R. Arnold, 460,245. Filed Nov. 10, 1890.
Has for its object to obviate injury to the switch contact and danger of damaging the armature or field-magnet cores of the machine.

Lightning Arrester, J. J. Wood, 460,289. Filed Sept. 25, 1890.
Relates to lightning arresters applicable to the ground connection of electric circuits generally.

Electric Lock, W. S. Hull, 460,391. Filed Dec. 31, 1890.
Claim 1 follows:
The combination of the main latch bolt of an auxiliary bolt suspended to swing into line with, and contact with, the end of said bolt and an armature of an electromagnet connected with said auxiliary locking device by jointed connections.

Push-Button, J. E. White, 460,416. Filed Aug. 21, 1891.
A push-button which may also be used as an automatic alarm in case of fire.

Method of Soldering or Brazing by Electricity, C. L. Coffin, 460,428. Filed Apr. 17, 1890.
Method consists in connecting the material to be soldered to one pole of the generator and the soldering tool to the other pole and passing a current through the two and the material.

Insulator, F. A. Ross, 460,448. Filed Dec. 16, 1890.
An insulator in which the use of binding wires is avoided and upon which the conductor may be securely clamped without injury to the insulation or the wire itself.

Apparatus for Holding and Sewing Carpets, R. M. Hunter, 460,504. Filed June 4, 1890.
A system of holding and sewing carpets by means of electrically operated machinery.

Apparatus for Holding and Sewing Fabrics, R. M. Hunter, 460,505. Filed Sept. 22, 1890.
Similar in its object to 460,504.

Apparatus for Holding and Sewing Fabrics, R. M. Hunter, 460,506. Filed Oct. 13, 1890.
Similar in its object to 460,504.

Apparatus for Holding and Sewing Fabrics, R. M. Hunter, 460,507. Filed Nov. 1, 1890.
Similar in its object to 460,504.

Apparatus for Holding and Sewing Fabrics, R. M. Hunter, 460,508. Filed Nov. 1, 1890.
Similar in its object to 460,504.

Electric Crane, W. A. Stadelman, 460,514. Filed March 11, 1891.
An electric crane in which the current is carried by a flexible cable instead of a trolley.

Thermal Cut-Out, J. O. Phillips, 460,538. Filed Jan., 1891.
A thermal cut-out for pendant incandescent lamps, which may be placed at an intermediate point between the lamp and the ceiling.

Electric Elevator, R. C. Smith, 460,541. Filed Dec. 31, 1890.
Has for its object to provide means whereby the motor connected with the elevator will be automatically cut out of circuit in case of an excessive counter-electromotive force induced.

Railways and Appliances :—

Trolley for Electric Railways, F. F. Smith, 460,163. Filed Dec. 20, 1890.
Intended to prevent the trolley from being thrown off the wire when the car is passing around curves.

Self-Lubricating Trolley, W. Hoen, 460,232. Filed April 13, 1891.
A trolley wheel having internal chambers for receiving dope, these chambers opening into the central bore of the pulley.

Trolley-Switch, H. L. Pierce, 460,488. Filed Oct. 22, 1890.
Relates to switches for the conductors of electric railways, operated by the mere passage of the trolley wheel.

Telegraphs :—

Telegraphic Transmitting-Instrument, C. G. Burke, 460,109. Filed June 17, 1890.
Has for its object to give to the transmitting operator perfect control over the length of actual contact for each impulse and to enable him to vary the potential and relative periods of contact between reversed polarities.

Telegraphic Instrument, C. G. Burke, 460,110. Filed Dec. 26, 1889.
A receiver or relay for long lines or submarine cable circuits of great sensitiveness and delicacy of operation and of simple construction.

Telegraphic Instrument, C. G. Burke, 460,111. Filed Feb. 11, 1891.
A receiver or relay intended to respond rapidly and accurately to signaling circuits and to produce especially clear and distinct records.

Printing-Telegraph, J. E. Wright, 460,328. Filed Dec. 30, 1890.
A printing telegraph in which the impressions are made in line across a web or sheet of paper of the desired width.

Printing Telegraphic Apparatus, G. A. Cassagnes, 460,349. Filed Nov. 28, 1890.
Invention pertains mainly to improvements in the printing receiver.

Printing Telegraph Instrument, J. E. Wright, 460,457. Filed Dec. 31, 1889.
Consists of a rotary type wheel turned by a clock motor and an electromagnetic controlling device regulating the movement of the motor.

Legal Notes.

WESTERN UNION TELEGRAPH CO. vs. LINDDELL—FAILURE TO DELIVER MESSAGE.

In this suit the Supreme Court of Mississippi has decided as follows: In order to sustain an action for damages for failure to deliver a telegram it must be shown that a contract, actual or implied, existed between the sender of the message and the company. Where a man writes a message on a leaf of his note-book, tears the leaf out, and sends it by a messenger to the telegraph office without paying or offering to pay or agreeing to become responsible for the charges for sending it, no contract exists between the parties, and no recovery can be had against the company for failure to deliver.

THE U. S. vs. SOUTHERN PACIFIC R. R., WESTERN UNION, ETC.

A suit has just been brought, in Washington, before Justice Field, of the Supreme Court, sitting as a circuit judge, with the object of canceling the exclusive contracts between the Western Union Co. and various railroads. The parties defendant are the Southern Pacific Railroad Company, the Southern Pacific Company, the Atlantic and Pacific Railroad Company, and the Western Union Telegraph Company. The purpose of the suit is to break the monopoly now possessed by the Western Union Company in the telegraph franchises through the country traversed by the road lines involved, and the instigators of the proceeding on the part of the Government are the same as the instigators of the legislation under which the suit is brought, namely, the old Baltimore and Ohio Telegraph Company and the Postal.

The theory of the Government case is that the grants to the railroads were made by Congress as much for the purpose of having telegraph lines maintained for the public benefit as for having rail transportation facilities; and hence that the railroad companies exceeded their powers when they made leases transferring control of their wires to any other corporation.

Mr. Chas. E. Gregory, general manager of the Hyde Park Electric Light & Power Co., has resigned to take a position as general salesman for the Standard Electric Co., of Chicago.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

"In this age of electricity, any man who advertises can accomplish in two years what formerly took ten."

THE WESTON AUTOMATIC ENGINE.

THE accompanying illustrations, Figs. 1 and 2, show the new automatic engine manufactured by the Weston Engine Co., of Painted Post, N. Y. The bed of this engine is made especially heavy to guard against any springing tendency, and the guides are planed in the bed and accurately scraped. The cross-head shoe is adjustable to accommodate any wear, always leaving the engine in correct alignment. The main bearings have adjustable cheek-pieces to take up the wear, and all bearings are sufficiently generous to satisfy the most radical advocate of large wearing surfaces. The reciprocating parts are balanced by weights in the crank discs. The cylinder and steam chest are in one casting, and made from the best charcoal iron. The piston is made hollow and cast-iron rings are sprung in for packing. The cast-iron jacket allows the cylinder to be covered on the outside with mineral wool to prevent radiation of heat. Interchangeability of parts of these engines forms a valuable feature.

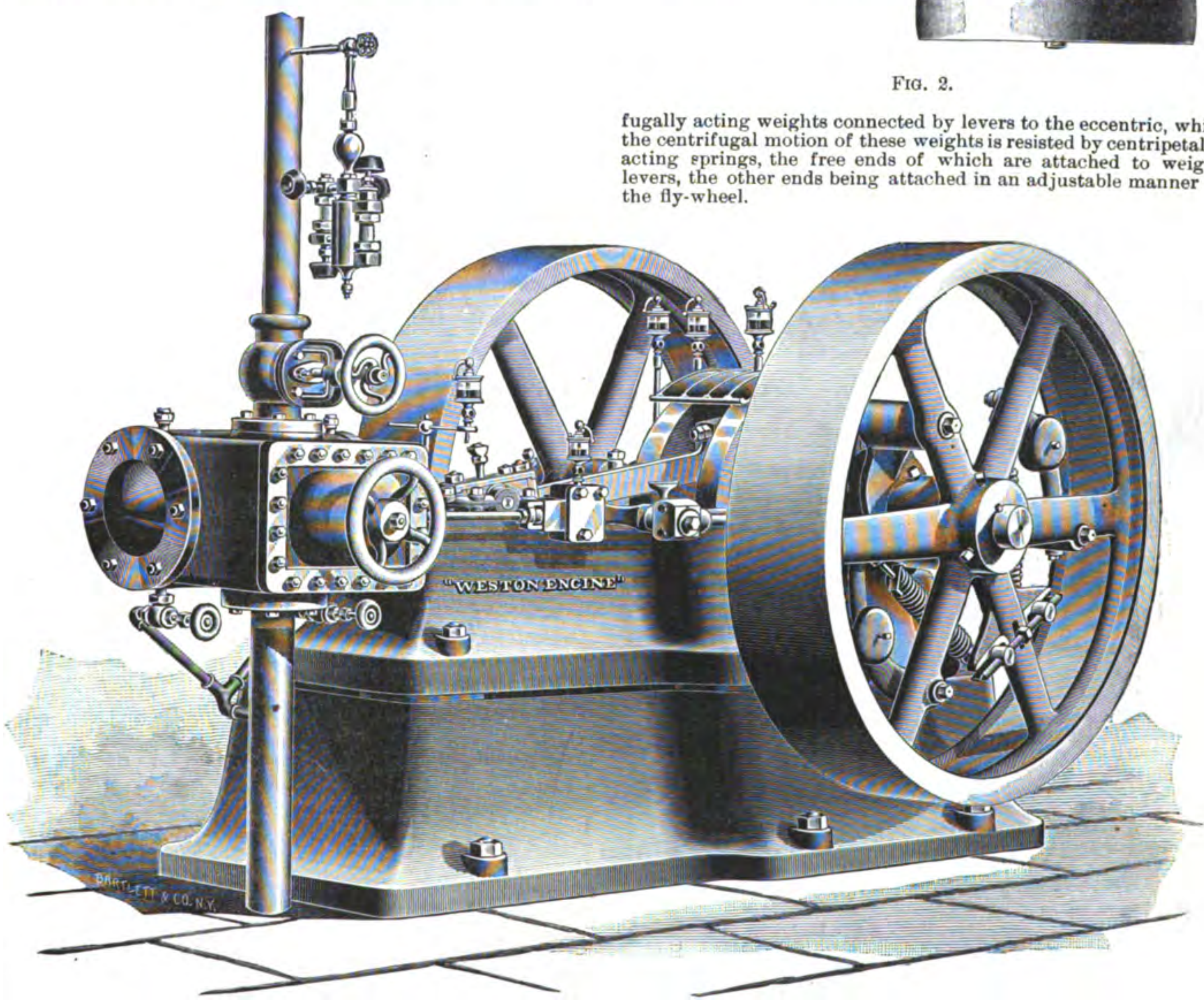


FIG. 1.—THE WESTON AUTOMATIC ENGINE FOR ELECTRIC LIGHTING.

The action of the valve is clearly shown in Fig. 2, and gives four openings for the admission of steam, the length of each equal to the diameter of the cylinder. This, together with a large travel and ample ports, gives, as might be expected, a high steam line and a sharp cut-off. The exhaust is through a double opening, and is attended with the same advantages that characterize the steam admission.

The governor, Fig. 3, has a laterally movable eccentric surrounding the crank-shaft of the engine, by which the admission of steam to the cylinder is regulated through the variation of its throw. This variation is effected by the movements of centrifugally acting weights connected by levers to the eccentric, while the centrifugal motion of these weights is resisted by centripetally acting springs, the free ends of which are attached to weight levers, the other ends being attached in an adjustable manner to the fly-wheel.

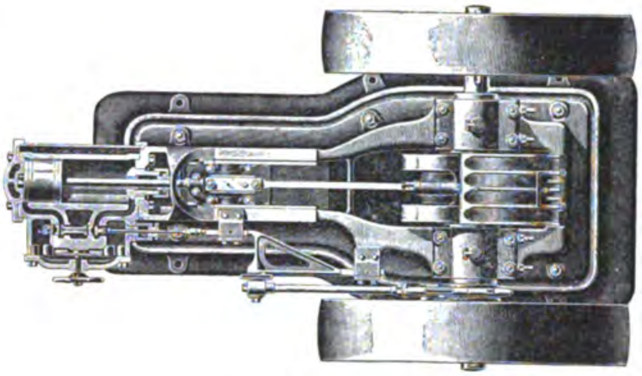


FIG. 2.

With the governor at rest, the tension of the springs will hold the eccentric in position of the greatest throw, but in action the centrifugal force of the weights moves the eccentric across the shaft, reducing its throw as increased rotary motion takes place, until it reaches the point where the valve travel will be in accordance with the amount of steam necessary to drive the load. It is apparent that for any nicety of regulation, the centrifugal force and the centripetal force, as supplied by the weights and springs, should be in equilibrium.

An inspection of Fig. 3 shows how this is accomplished, an arrangement which allows both springs to have their attachment to the wheel on the same side. This admits of a right and left hand screw, with a nut in the centre, being inserted in the two-spring attachment pins, the turning of which moves simultaneously, and an equal distance, the two springs nearer to, or farther from, the pivotal points of levers, thus accomplishing the regulation of the governor to a degree equaling isochronism, if desired.

FIG. 3.

— The New York representatives of the Weston Engine Co. are Messrs. Julian Scholl & Co., with offices at 40 Cortlandt street.

THE BERNSTEIN ACID AND WATERPROOF SOCKET.

Bernstein Socket.

WE illustrate herewith a new form of waterproof socket which has been designed for special use in paper and pulp mills, breweries, marine work, and all places where the use of the ordinary socket is impossible because of the presence of moisture or attacking acid fumes. The body of the socket consists of two hard rubber parts, all the stampings inside being made of phosphor bronze. Rubber gaskets at "A" and "B" protect the lamp cap and the internal parts of the socket, making it perfectly waterproof and gas proof. The socket is adapted for lamps with the Thomson-Houston cap, and is furnished complete with leading wires, as shown, all ready to connect into circuit. These sockets are manufactured exclusively by the Bernstein Electric Company, 620 Atlantic avenue, Boston.

"A FEW ADVANTAGES OF ELECTRIC HEATING."

THE Electric Merchandise Co., 11 Adams street, Chicago, as agents for the Burton Electric Co., have issued a circular entitled as above. It is pithy and pointed, and gives some excellent hints to street railway men on the desirability of heating their cars electrically. On the back are blazoned the five cardinal merits of "convenience," "comfort," "economy," "safety," and "cleanliness."

PAGE BELTING CO.

AMONG the recent orders of the Page Belting Co. is one for a complete outfit for the Derry Electric Light Co., of Derry Depot, N. H., and an outfit for the Concord Gas Light Co.'s new station. Main belts have been furnished as follows:

A 26-in. belt for the Southwestern Electric Light and Water Power Co., at Joplin, Mo.; One 58-in. belt, 127 feet long, for the Reading Electric Light and Power Co., Reading, Pa. This party also had about 800 feet of 12-in. Eureka dynamo slotted belt; a 16-in. belt for Dayton, Ohio, and three 48-in. belts for the Georgia Electric Light Co., at Atlanta, Ga. They have also furnished of their new Eureka dynamo slotted belts as follows:

One 12-in. belt for the Concord Street Railway; one 13-in. belt for New York City; two 18-in. belts for Raleigh, N. C.; four 14-in. belts for the Schuylkill Electric Railway Co., at Pottsville, Pa.; two 8 in. belts for Piqua, Ohio; one 14-in. belt for Boston; one 10 inch belt for Amsterdam Street Railway Co., Amsterdam, N. Y.

Of regular dynamo double belting they have furnished as follows:

One 12-in. belt for the Hyde Park Electric Co., Hyde Park, Mass.; three 13-in. and one 10-in. belt for the Birmingham Railway and Electric Co., Birmingham, Ala.; eight 20-in. belts for Chicago.

A NEW NON-CORROSIVE BATTERY.

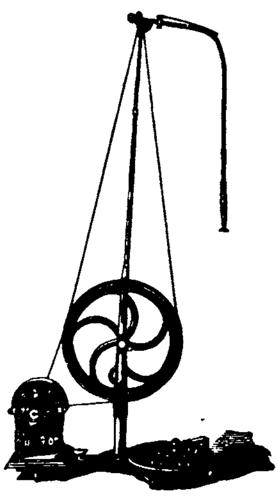
Non-Corrosive Battery.

WE illustrate this week a new form of open circuit battery which bids fair to make a very favorable impression, and which possesses some features quite new and very valuable. A thin plate of zinc is used, instead of a heavy pencil or cylinder of zinc, as in the majority of other batteries, and no corrosion of the zinc takes place. The solution only is destroyed, and it is very cheap. The battery, like others, will polarize, but recuperates very quickly, and there is no local action. The fact that a thin plate of zinc can be used, owing to the increased surface, enables the battery to give out a large current. The zincs are not amalgamated, as there is no necessity for doing so, owing to the fact that the zinc is not consumed. This battery opens up an entirely new field, it being something new to see a battery whose zincs are just the same after months' hard usage, and it is well worthy of consideration. The Consolidated Electric Manufacturing Company, of Boston, are the selling agents and they will cheerfully furnish any information desired.

THE EDISON ELECTRIC DENTAL DRILL.

THAT the practical applications of electricity to useful service are as limitless as electricity itself is evident from the new developments constantly being made.

Of a striking character is the new combination $\frac{1}{16}$ h. p. Edison motor and dental drill, shown in the accompanying illustration.



Edison Electric Dental Drill.

An ordinary dental drill is used, the foot lever and crank being removed. The old pivot is utilized to fix a strip of steel upon which can slide the $\frac{1}{16}$ h. p. Edison motor, arrangement being made to clamp it in any position, so that the belt can be kept at any desired tension. The motor, therefore, occupies one of the legs, and the other two legs are used to support the reversing and resistance switch. The handle of the switch is of a special construction so that the operator can use it as readily as the treadle. It is arranged to project over the edge of the resistance coil, and the operator can, by a slight movement of his foot, switch it over to either side, so that the motor runs in either direction at will.

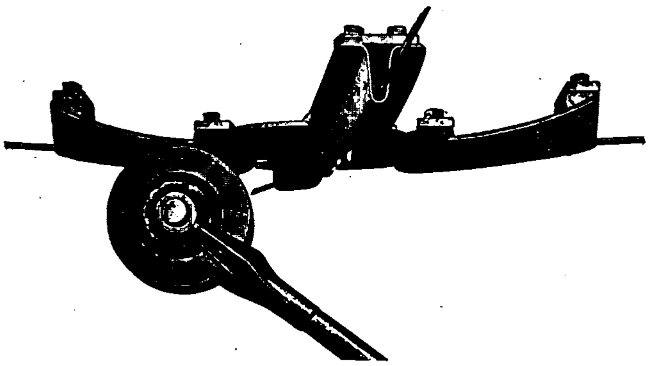
If the arm is in the central position, the current is off. If between the central position and one side, the motor runs in one direction, but not at full speed.

Catch clips are arranged so that the operator can tell immediately he has reached either the "off" position or the "full on" position on either side. He can also obtain four different speeds below full speed. The motor is designed to run on 125-volt circuit, so that it can be used on a local electric light circuit. A wall socket is fixed near the dental chair and a flexible cord led from this to two terminals on the motor.

One advantage of this arrangement is that it insures good and safe work and enables the dentist to concentrate his whole attention and effort upon the work before him.

THE "MINNEAPOLIS" TROLLEY CROSSING.

THE accompanying illustration shows a trolley-wire crossing made by the Minneapolis Brass and Iron Manufacturing Co., of Minneapolis, Minn. It adjusts itself automatically to any desired angle, and is equally efficient with any size of wheel or wire. An



MINNEAPOLIS TROLLEY CROSSING.

important item in regard to these crossings is that they require no soldering, are easily put up, and may be readily shifted or removed. The company state that 1,000 consecutive cars passed one of these crossings in one day, recently, without a single trolley leaving the line.

THE HEISLER CO. AT THE MONTREAL EXHIBITION.

WE are in receipt of the following from Mr. Walter F. Smith, the general manager of the Heisler Electric Light Co., of Philadelphia :

"We wish to enter a mild complaint against the treatment that we received at the hands of the Management of the Exhibition.

"As a matter of course, we did not determine upon making any exhibit until it was rather late. However, before taking any steps in the matter, we communicated with the officials in charge and were assured by them that there was still available sufficient space to enable us to exhibit our apparatus. Upon its arrival there we were very much disappointed at being alloted a space where we could procure no power for the purpose of operating our dynamo. We would, under no circumstances, have made any display had we known it would be impossible to have shown the apparatus in full operation. We regret the circumstances exceedingly, not alone for ourselves, but for the many individuals who visited the exhibition, who were interested in our apparatus, especially in the operation of it. As it was, we were placed in the position of being practically shut out from making any display whatever. You will readily appreciate that the fact of the apparatus standing there to be looked at was not satisfactory to those interested in electric lighting, much less satisfactory to us. We think it was a serious oversight on the part of the management to have shut us out in this manner and given foreign corporations the preference, and would respectfully request that you avail yourself of the first opportunity to make mention of this fact in the columns of your paper, in the form of a notice to your many readers, extending to them our regrets at being unable to show our apparatus in operation; and assure them that it was not our fault, as we made every effort possible to secure the necessary power, but failed."

ALEXANDER, BARNEY & CHAPIN.

ILLUSTRATIONS of remarkable progress by electrical corporations are by no means rare, yet there are few so striking as that furnished by the firm of Alexander, Barney & Chapin, of this city, who, on October 6th, completed the first year of their business life. The supply business is one which has during the past few years drawn to itself a large amount of capital. In the West, particularly, there have been several new organizations started. In the East, however, we know of no example of rapid increase in business more striking than that furnished by the Cortlandt street firm. On October 6th, 1890, they opened their store at 20 Cortlandt street, occupying a space about 30 feet front by 130 feet in depth; their entire force consisted of seven men. The first day, which was given up largely to the hospitalities of house-warming, 25 orders were booked, and those 25 customers still remain on the books of the firm as current buyers. The number of employees has now increased to 28, while the number of customers has reached the astonishing figure of about 2,000, and the floor space occupied has been doubled. When it is considered that the business of this firm has come almost entirely from central electric lighting stations, isolated plants, bell hangers and contruction companies, it is certainly surprising to note the volume of trade which has found its Mecca with the house of "A. B. & C." The electric railway supply business, which has, with some electrical supply companies, compensated for the present competition in the electric lighting field, has not heretofore been sought after by this firm, but encourged by the support they have received from their present customers, they are about to open a department for the manufacture and sale of electric railway specialties, which, as it will be the only one of its kind in the Eastern country, will assuredly be as profitable as their departments for household goods and electric light supplies.

Alexander, Barney & Chapin have just issued several pamphlets regarding their "A. B. C." incandescent lamps, in which they cite various testimonials from customers, certifying to the fact that some lots of their lamps have burned for periods averaging from 2,000 to 6,000 hours. This does not mean that one, two or three lamps have burned that long, but that lots of from 50 upwards have earned this record.

NEW "CENTRAL ELECTRIC" TRADE-MARK.

THE Central Electric Company are out with a new trade-mark. The device represents the Continent of North America faintly outlined on a disc, having the principal cities plainly shown all in connection with Chicago. The words "Central Electric Company" are boldly drawn across the continent, and the well-known trade-mark of the Okonite Company encircles the North and South Poles. We expect this "cannon ball" trade-mark well become as well-known as the famous Okonite sign.

NEW ENGLAND NOTES.

THE CORLISS ENGINE COMPANY, of Providence, have recently started up the engine which they supplied to the Augusta, Hallowell and Gardner Street Railway. The engine is 200 h. p. compound condensing and has cylinders 14 inches and 28 inches by 36 inches stroke. They are also setting up for the Woonsocket Electric Light and Power Company, of Woonsocket, R. I., a twin compound condensing engine of 700 h. p., with cylinders 22 inches and 44 inches by 60 inches stroke. The Connecticut Electric Company, of Waterbury, have recently ordered another compound condensing engine of 400 h. p., with cylinders 18 inches and 32 inches by 48 inches stroke, and two vertical water leg boilers to furnish steam for same. The Corliss company are also furnishing six single non-condensing engines, with cylinders 40 inches by 72 inches stroke, for the Third Avenue Cable Road, in New York, each having a 25-foot balance-wheel, weighing 85,000 pounds. The Chicago West Side Cable Road has ordered a 36 x 72 inch single non-condensing engine, and six of the Corliss company's special boilers. The Corliss Engine Company have also supplied four boilers with an aggregate of 1,000 h. p., to stand 165 pounds pressure, to the California Electric Light Company, of San Francisco.

THE BRADBURY-STONE STORAGE BATTERY COMPANY, of Lowell, Mass., have achieved a success in their recent equipment of electric cars in Sioux City, Iowa, with their system of storage batteries. In this city there are a large number of heavy grades and sharp curves, one of which is a mile long, all of which have been successfully overcome, the cars ascending the hills with ease. The motor in the car is made to act as a dynamo in descending grades and is used to change the batteries, thereby utilizing the energy which would otherwise be lost. The Bradbury-Stone "Ideal" storage battery possesses a number of advantages, the electrode being light and practically indestructible, being braced in every way to make it substantial, and is capable of standing heavy drafts of current. The active material is treated electrically before inserting into the electrode, which is done by cutting it up into strips to fit recesses in the plates. A battery can thus be easily kept in repair as it is an easy matter to withdraw any defective parts.

MR. C. H. HERRICK, of the Wright Electrical Engineering Company, of Boston, has received an order from the Haverhill Electric Light Company, of Haverhill, Mass., to act as their consulting engineer, furnish the complete plans, and take the whole supervision of the work. The station will be designed for 1,500 h. p., and the engines will be furnished by the Corliss Steam Engine Company, of Providence. Return tubular boilers will be provided to furnish the steam.

THE EDISON GENERAL ELECTRIC COMPANY, through their Boston office, have secured the contract for a central station in Penacook, Me., consisting of 1,000 lights, which will be used for general lighting of stores and houses. They have also contracted to put in a central station in Plymouth, N. H., of 1,500 light capacity at present, and will light up about three miles of streets in addition to the general lighting.

THE DAVIDSON VENTILATING FAN COMPANY, of Boston, are making a specialty of manufacturing a very compact and efficient fan for all kinds of ventilating purposes. These fans can be driven by electric or other power, and large numbers of them are in use in mills, mines and buildings of every description. These fans are of strong design with steel blades, babbitted self-oiling boxes, and owing to the peculiar shape of the blades, having both a concave and convex surface on each side of the blade, give a uniform delivery over the whole face of discharge without any reflex action. The Davidson company have their headquarters at 52 Pearl street, Boston, and their factories at Cambridgeport, Mass., and they are thoroughly well equipped to supply fans for every purpose, which will give entire satisfaction.

THE GERMANIA ELECTRIC COMPANY, of Boston, have sold a 350-light Germania incandescent dynamo for the new hotel on Huntington avenue, Boston; a 110-light dynamo for Byrne Brothers, Lodi, N. J., complete with improved Schaefer lamps and sockets, and a 25-volt, 75-ampere dynamo for running special electric engine-turning lathes. The Germania company have also recently secured the contract for the complete installation of a central station for the Portland Electric Light Company, of Portland, Conn. The plant will consist at present of a 30-arc light dynamo, and a 750-light alternating incandescent dynamo, with Freeman transformers. The lamps will be used for both street and commercial purposes. The Germania company have the contract to erect the station and do the whole of the construction work.

CAPTAIN DE KHOTINSKY, of the Electriciteits Maatschappij, of Rotterdam, inventor of the well-known de Khotinsky system of incandescent lighting, has arrived in this country, and has attached himself to the Germania Electric Company, of Boston, who have secured his patents for this country. The Captain will at once commence installing a plant for manufacturing the Khotinsky lamp, which, it is worthy of note, is the only lamp used for lighting the Frankfort Exhibition. The Captain is feeling rather elated at the outcome of the recent decision in France in his favor of the suit brought against his Rotterdam company by the united Edison and Swan companies.

THE RUSSELL ELECTRIC COMPANY, of Boston, have since the first of June installed the Russell disc carbon lamp in 32 central stations, one station, the Suburban Electric Light Company, of Scranton, Pa., having as many as 88 lamps in use, 25 of which are used for inside work, the rest being in use for outside purposes. The Arlington Mills, at Lawrence, Mass., have 25 Russell lamps in service of their regular 12-hour type, burning 23 hours a day, using a special oval carbon, ⅞ x ⅝ inch.

THE EASTERN ELECTRIC SUPPLY COMPANY, of Boston, have sold two electric snow-plows to the Lynn Belt Line Street Railway Company, of Lynn, Mass. This makes 18 snow-plows which they have supplied to electric railways this fall. These plows are of their own construction and were designed by Mr. Wallace, in charge of the electric railway branch of their business.

THE UNION MANUFACTURING COMPANY, of Bridgeport, Conn., are well pleased with the way in which their new socket appears to take with the trade. Orders continue to come in rapidly and the Union Company are desirous of finding agents for them in different cities.

PHILADELPHIA NOTES.

THE IMPERIAL ELECTRIC CO. is the name of a new company just incorporated in this city and located at 1218 Filbert street, for the purpose of manufacturing and selling switches, sockets, cut-outs, branch blocks, fuse blocks, tapes, insulating compound and many other electrical specialties, most of which will be made under their own patents. The incorporators are men of ability, several of whom are well known in electrical circles. The officers of the company are as follows: J. S. Spruance, president; J. C. Corbit, Jr., secretary and treasurer, and John Mustard, general manager.

MR. N. A. WOOD, one of the oldest electricians in this city, has sold his electrical construction and supply business to Messrs. John Cunningham, Jr., and W. S. Ambler, who will conduct the business at the old stand, 1123 Chestnut street, under the firm name of Cunningham & Ambler. The senior member has been connected with the Cornish-Bell Co., of this city, during the first eight years. At present Mr. Wood is connected with the Eastern Pennsylvania Phonograph Co.

MR. ROBERT H. ENGLE, of this city, has just completed a very creditable job of enameled wiring at the new shoe store of E. Ryan, corner of 20th and Christian streets. The combination gas and electric fixtures are finished in antique copper, and are one of the handsomest patterns made by the Thackara Manufacturing Co.

MR. R. W. EDDSON, of the Fowler-Waring Cables Co., North Woolwich, England, is on a short sojourn to this country on business for his company. Mr. Eddson while here is making his headquarters at Messrs. Tatham & Bros.

MR. T. L. TOWNSEND, salesman for the Partrick & Carter Co. left this city last week on his regular fall trip. He will cover the Southern, Western and Northwestern territory pretty thoroughly before his return.

MR. C. W. CARNES, formerly with C. M. Blanchard, has accepted a position as traveling salesman for M. S. Shapleigh.

NEW YORK NOTES.

MR. E. W. LITTLE, the energetic young manager of the Interior Conduit and Insulation Co., has been down with a severe attack of typhoid fever, but has turned the corner and is now convalescing. It will be some few weeks, however, before his physicians will allow him to resume work.

MR. HARRY MADDEN, late manager for the Empire City Electric Co., has been appointed New York agent for the New Haven Insulated Wire Co., with office at 18 Cortlandt street, New York. The agency is in excellent hands.

WESTERN NOTES.

ELECTRIC LIGHTS FOR THE BOULEVARDS.—A new plan for lighting Drexel and Grand boulevards, Chicago, has been proposed by Prof. Barrett, City Electrician, and Ald. Cullerton. The South Park commissioners contemplate erecting a power house in Washington Park to light it by electricity during the World's Fair and thereafter. Prof. Barrett has suggested that the plant be built so as to furnish power not only for the park lights, but also for boulevard lights. If the park commissioners supply power from the Washington Park plant for electric lights along Grand Boulevard as far as 35th St., the city, it is said, will provide power for lights on Michigan Boulevard from its commencement at Jackson st. to 35th and on Douglas to Grand, connecting with the park lights. The Washington Park, as estimated, will cost $70,000. It is understood that the city's appropriation for electric lights this year has already been spent, but probably some arrangement can be arrived at which will enable the new lights to be placed where they are so much to be desired.

THE ELECTRIC GAS LIGHTING CO., of Boston. Mass., have now got their branch office in the Lakeside Building propitiously started off. Mr. Charles E. Lee, well known amongst the Western electrical fraternity, is in charge and will be pleased to see his many friends and furnish them with any supplies they need. A large line of specialties are now being carried in the Chicago office, including electric gas lighting apparatus and supplies, the Tirrell gravity drop and the new "Hub" needle annunciators, the Victor, the Champion, Standard and Success electric bells, and the well-known Samson batteries, and also a large general assortment of electrical supplies.

J. LANG & CO. have just completed a large number of the Lang switches for heavy current work. These switches are great favorites on account of their large and efficient carrying capacity and the entire absence of heating. Mr. Lang attributes his success to the excellent quality of the material employed and the high class of workmanship which is to be found in all his goods.

THE ELECTRIC MERCHANDISE CO., 11 Adams street, Chicago, are very busy filling orders for street railway supplies. They are receiving numerous inquiries from all parts of the world regarding the specialties for electric railways which they manufacture and handle.

THE ILLINOIS ELECTRIC MATERIAL CO. report the demand for "Canvas Jacket" line wire, Bishop india-rubber wires and cables as very brisk. In general supplies for electric lighting, power and railway work they are doing a flourishing trade.

THE CENTRAL ELECTRIC COMPANY report that eight of the large buildings now being constructed in Chicago, to contain in the aggregate 14,200 incandescent lamps and 650 arc lamps, are being wired with Okonite wire.

MR. FRANK N. WATERMAN, who has had charge of the construction work on the new Westinghouse railway at Burlington, Iowa, was in Chicago last week.

MR. JAMES A. LOUNSBURY, a well-known electrician in the West, has associated himself with the Chicago office of the Westinghouse Electric and Manufacturing Co.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE

Electrical Engineer.

VOL. XII. OCTOBER 14, 1891. No. 180.

THE FRANKFORT INTERNATIONAL ELECTRICAL EXHIBITION.—IX.

BY

L. Gutmann.

The Lauffen-Frankfort Transmission.

ALL electrical engineers have been interested in the famous transmission of power from Lauffen to Frankfort, and while this is the topic of the day, other transmissions of less gigantic a nature have hitherto been overlooked. The saying is, when the sun shines, the stars are invisible. Before calling your readers' attention to other interesting exhibits, however, it may be said that the current sent from Lauffen has a pressure of 16,000 to 18,000 volts, and 30 to 35 periods of alternation per second. One of the reasons for the reduction in pressure has to be looked for in the fact that the large style or compound insulators of the Johnson & Philipp type, which were to be used, could not be obtained in sufficient number, so that the rest are of the simple type of fluid insulators. Another is the carrying capacity of the conductor, which, with high potential, would cause excessive heating, especially as the oil prevents the radiation, unless choking devices are employed. After the Exhibition is over it is contemplated to raise the pressure to 30,000 volts or more for carrying on the examination of this system by government and other officials.

The Lahmeyer Exhibit.

Pending these experiments, I wish to draw attention to the neat exhibit of Lahmeyer & Co., whose system, as will be seen, is thoroughly worked out. In the Central Machine Hall, shown in Fig. 1 of the accompanying illustrations, there is exhibited in operation a dynamo generating 110 amperes continuous current at a pressure of 660 volts, driven by an engine of the Nurnburger Maschinenbau Aktiengesellschaft, formerly Klett & Co., and another dynamo with the same pressure, but only 70 amperes, driven by a Westinghouse engine of the firm of Garrett, Smith & Co., Magdeburg-Buckau. The general appearance of the compact dynamo is shown in Fig. 1. It is of the four-pole type, the magnets of which project inward towards the armature. The latter is provided with a commutator and but two brushes. In this case the inter-

FIG. 1.—THE LAHMEYER EXHIBIT AT THE FRANKFORT ELECTRICAL EXHIBITION.

nal grouping of the armature winding is not made, as is often done, by cross-connection or coupling in parallel, but the windings or coils having similar positions in the magnetic field, are wound in succession, and therefore are in series with one another. In spite of the pressure, which in these separately-excited dynamos is above the average as regards machines with ordinary commutators, the sparking is quite negligible.

Another dynamo, having a capacity of 150 amperes at 110 volts, is operated by a triple-expansion engine of Gebr. Sachenberg, of Rosslau am E. The current of this dynamo is used for lighting the central station and the surrounding exhibits, and, furthermore, to excite the fields of the two first-named generators, which in turn are connected to busbars common to both, energizing a direct current transformer and a motor of 60 h. p., also shown in Fig. 1, which drives a large pump for supplying water from the River Main to the waterfall in the Exhibition grounds. The transformer and motor are of similar construction, with the difference that in the transformer there are wrought iron pole-pieces, which in the motor are of cast iron, and the armature windings are evidently different with regard to length and cross-section, depending on the use to which the device has to be put. In one case all the energy is transformed from high tension to low, while in the other most of the power is used to do mechanical work, and one-seventh or eighth is used for lighting, and at the same time energizing the field magnets. All other arrangements being identical, the transformer may be described by reference to Fig. 1 which shows the motor, the pump in front, and the switchboard to the right.

The transformer has an external appearance similar to the generator with the difference of having two commutators and two sets of brushes. The capacity of the one exhibited is 300 lamps, and the ratio of transformation is 6 : 1. The current with a pressure of 660 volts is transformed to one of 110 volts. Some of the station instrument readings are : Primary, volt, 682, amp. 14.5 ; secondary, volt, 110.5, amp. 72.5; primary, volt, 670, amp. 20; secondary, volt, 108, amp. 10.5; primary, volt, 670, amp. 14 ; secondary, volt, 110, amp. 72. The efficiency of these first machines, as these figures show, is between 81 and 85 per cent. at one-third or one-half load of total capacity of 200 amperes. The armature is provided with two separate sets of windings, one capable of developing or receiving currents under a pressure of 660 volts, while the second produces currents at 110 volts. The field winding consists of four coils, the first layers of which are separable from the rest, and are connected to the terminals of the rheostat, and also to a two-way switch on the switchboard.

This board is clearly shown in detail in Fig. 1. In the upper row are located the line terminals and others for connection behind the switchboard. The two central and circular instruments are the voltmeters for the high and low tension circuits ; to the left is the high-pressure ampere meter, and to the right, one for the low-tension circuit, the indices of which are steadied by moving in mercury. To the right of these is the main primary double pole, double break switch, while to the extreme left is a similar one for the low-tension circuit. The two handles to the left of these main switches are releasing levers for opening the circuits manually, while the relays below the ammeters are for the purpose of effecting this operation automatically in case of abnormal circuit conditions. The device below the voltmeters consists of a rheostat and an electromagnet, whose armature is shown released. The two-way switch at the lower central part of the switchboard is that one to which the extra layers of the field windings are connected for joining them to, or cutting them out of, the low-tension circuit. In the right-hand corner we observe further the main fuses enclosed in glass tubes.

We are now ready to start the operation, and close the high and low pressure circuits while the two-way switch is touching the lower two points, and the resistances of the rheostat are all in the circuit. In this position the transformer acts as a series motor, in which the armature and the separate field winding receive the 660 volt current. The armature begins to turn with very little sparking indeed, increasing in speed as the resistances are gradually cut out. Depending on the load of the circuit, the secondary may be closed after the secondary armature winding has picked up, which takes place in about 10 to 15 seconds. The rheostat lever is turned to the last point, in which position the extra field winding is cut out, and the high pressure current then circulates through only one of the armature windings. Meanwhile, the low-pressure winding has established its current, and supplies or excites its field magnets which are in shunt to the 110 volt brushes. The excitation has reached its normal condition after all resistances are cut out, and by turning the two-way switch into the second position, the extra or separate field winding is placed in series with the other layers.

In constructing this and similar devices, safety in handling was one of the principal objects, and the inventor has therefore decided to have no high-pressure winding on the field at all when the apparatus is in normal working condition. As a further safeguard, an automatic device is mounted on the switchboard, consisting of an electromagnet, situated over a rheostat, by which, when energized by the high-tension circuit, the armature is attracted. The switchboard is now in normal working condition.

The system when explained in detail seems to be rather complicated, but this is by no means the case. After the two main switches are closed, there are but three motions to carry out, viz., cutting out the resistances, grouping the field winding, and placing the armature of the electro-magnet, and it will be attempted to reduce these separate movements into two or one.

The ingenious part in designing these devices is the automatic action and the impossibility of doing harm by wrong connection or failure to turn a switch. The rheostat can be moved only in one direction and not backwards, and the electromagnet above it is in the primary circuit and releases its armature when there is a short circuit or a break on the line. The electromagnet, which in such a case is thrown out of circuit, can no longer hold the heavy iron armature, which drops back and opens the line by removing the rheostat lever from the last contact point, operating at the same time, by means of a special arrangement behind the switchboard, the primary main switch, while the transformer armature gradually comes to rest. It will be noticed that the rheostat contact arm is provided with a metallic sector, which is in the path of the two-way switch, and moves it to its original position. If this operation should not be complete, and the generator were started again at a distant station, after the fault had been removed, the consequence would be evident ; the generator would be short-circuited, as the transformer armature is at rest, and there would be no resistance in circuit. Such a mistake is impossible in this case, because the rheostat switch could not go back to the original position without first changing the position of the two-way switch.

All devices are thoroughly worked out, and the manipulation of the switchboard is as simple as that of any other system. When the transformer is in normal working operation the 660 volt current circulates through the armature only while the field in all all its parts is excited by the second armature winding, whose main current is used for lighting the lamps at a pressure of 110 volts. In the motor the high-tension commutator has a greater prominence than in the transformer, while the one for the low-tension circuit is smaller on account of the reasons given above.

This system of transformation is not the only one shown within the grounds of the Exhibition. Another one especially modified is carried out, bringing the energy from Offenbach to Frankfort, a distance of six miles. In Offenbach a separately excited dynamo produces 22 amperes under a pressure of 2,000 volts, which tension is kept contant. This current is conducted by means of bare overhead wires supported on fluid insulators, to Frankfort. This type of transformer is self-regulating, that is to say, if the tension of the 2,000 volts current is kept constant in the main station, the transformer maintains the pressure constant in the low-tension circuits at all loads, of course within a certain limit for which it is designed, in spite of increased drop on the line. This result can be obtained by coupling a motor to a compound dynamo which has so many more additional turns as to compensate for the difference of speed of the motor between no load and maximum. In this case there would be constant pressure

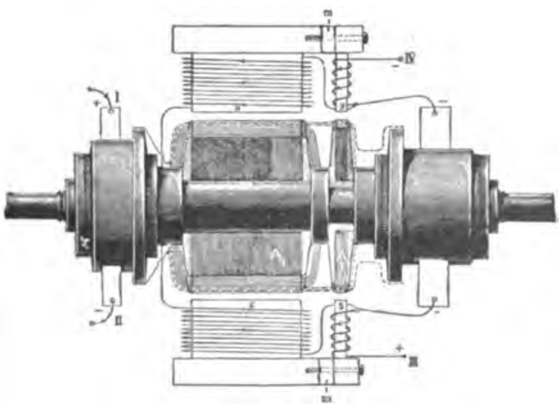


FIG. 2.

in the secondary circuit, but the efficiency of this combination would be less, and the expense of manufacture, and therefore, first cost price greater, than if both could be combined in one machine. If this latter is attempted, it will be found difficult to obtain constant pressure in the secondary circuit. The regulation of the two armature windings cannot be effected by the same means, because at increasing loads and constant speed, the motor winding requires a compensation of opposite character from that of the secondary winding.

Mr. Lahmeyer, however, has solved this question in the following manner : Fig. 2 represents the transformer in diagram. The armature, which is made for larger sizes of the Gramme ring type, is shown in here of the drum type. The high-tension winding is connected to the commutator to the left, on which rest brushes I and II connecting this winding with the high-tension source. These armature coils are wound around the main core, marked A_1. The secondary winding also surrounds the core A_1, but in addition a supplementary core A_2. Its terminals are finally led to the commutator to the right, on which rest brushes III and IV. The main field magnet is energized from brushes III and IV, and forms, therefore, a shunt to the low-pressure winding.

Separated from this field structure by non-magnetic metal *m*, is a small supplementary electro magnet, whose energizing winding takes the full secondary current. The regulation of this machine is similar to a compound wound dynamo, with the difference that the series winding is applied to a separate core and so arranged as not to influence the whole winding. Only the secondary coils are included in this small field. The current in these energizing field coils is proportional to the drop in pressure in the primary circuit, and in the same proportion the pressure is increased in the armature A_2. That is to say, if the pressure is kept constant in the central station, and the transformer is doing a certain amount of work, say for instance, one-half, and suddenly the load is increased to three-quarters, a greater current would be used in the secondary circuit, and a greater current would have to be supplied from the station. The drop on the line would be greater than on half load, and, if there were no compensation, the pressure in the low-tension circuit would drop also, but the supplementary field, carrying a series winding, has now an increased number of ampere turns, and creates a stronger field, while the secondary armature winding cuts a greater number of lines, which enables it to maintain the same pressure as before.

The apparatus is very carefully constructed, compact and well-balanced, and no sparking, or very little indeed, is visible between commutator and brushes on starting or shutting down the machine. Some readings taken on station instruments will give an idea of its efficiency. Primary, volts, 1845, amp. 7.6, secondary volts, 110 ; amp. 100; primary, volts, 1830, amp. 7.55, secondary volts, 109.5, amp. 100; that is, between 78 and 79 per cent. at half load, the transformer being designed to deliver 200 amperes at 10 volts.

THE LOCALIZATION AND REMEDY OF TROUBLES IN DYNAMOS OR MOTORS.—V.

(*Copyright.*)

BY

Francis B. Crocker and S. S. Wheeler.

NOISE.

1. Cause.— *Vibration due to armature or pulley being out of balance.*

Symptom.—Strong vibration felt when hand is placed on machine while running. Vibration changes greatly if speed is changed, and sometimes almost disappears at certain speeds.

REMEDY.—Armature or pulley must be perfectly balanced by securely attaching lead or other weight on light side, which can be found by trial. The easiest method of finding in which direction the armature is out of balance is to take it out and rest the shaft on two parallel and horizontal A-shaped metallic tracks sufficiently far apart to allow armature to go between them (Fig. 9.) If the armature is then slowly rolled back and forth, the heavy side will, of course, tend to turn downwards. The armature and pulley should always be balanced separately. An excess of weight on one side of pulley and an equal excess of weight on opposite side of armature will not produce a balance while running, though it may appear to when standing still; on the contrary, it will give the shaft a strong tendency to "wobble."

FIG. 9.—METHOD OF BALANCING ARMATURE.

2. Cause.—*Armature striking pole-pieces.*

Symptom.—Easily detected by placing the ear near the pole-pieces or by examining armature to see if its surface is abraided at any point, or by examining each part of the space between armature and field, as armature is slowly revolved, to see if at any point it touches or is so close as to be likely to touch when the machine is running. It is unwise to have a clearance of less than one-sixteenth inch full. Also turn armature by hand when no current is on and note if it sticks at any point.

REMEDY.—Bind down any wire or other part of armature that may project abnormally, or file out pole-pieces where armature strikes.

3. Cause.—*Shaft collars, shoulders, hub or edges of pulley or belt rattling against bearings.*

Symptom.—Noise stops when shaft is pushed lengthwise away from one or the other of the bearings. (See Heating of the Bearings, No. 7.)

REMEDY.—Shift collar or pulley, turn off shoulder on shaft, file or turn off the bearing, move pulley on shaft or straighten belt until they do not touch and noise ceases.

4. Cause.—*Rattling due to looseness of screws or other parts.*

Symptom.—Close examination of the bearings, shaft, pulley, screws, nuts, binding posts, &c., or touching the machine while running, or shaking its parts while standing still, will usually show the particular parts which are loose.

REMEDY.—Tighten up the loose parts, and be careful to keep them all in place and properly set up. It is very easy to guard against the occurrence of this trouble, which is very common, by simply examining the various screws and other parts each day before the machine is started.

5. Cause.—*Singing or hissing of brushes on commutator,* usually occasioned by rough or eccentric commutator (see Sparking at Commutator, No. 3), or by tips of brushes not being smooth, or the layers of a copper brush not being held together and in place; with carbon brushes, hissing will be caused by the use of carbon which is gritty or too hard. Vertical carbon brushes or inclined brushes running backward are apt to squeak or sing.

Symptom.—Sound of high pitch and easily located by putting the ear near the commutator while it is running, and by lifting off the brushes one at a time.

REMEDY.—Apply a very little oil to the commutator with the finger or a rag. Adjust brushes or smooth commutator by turning, filing or fine sandpaper. Carbon brushes are apt to squeak in starting up or at slow speed. This decreases at full speed, and can usually be reduced by moistening carbon brush with oil, care being taken not to have any drops or excess of oil.

6. Cause.—*Flapping or pounding of belt joint or lacing against pulley.* (Fig. 10.)

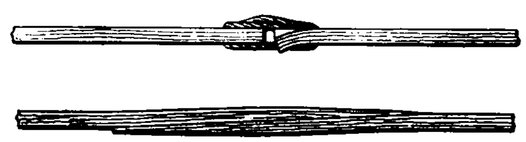


Fig. 10.—Bad Joints in Belt.

Symptom.—Sound repeated once for each complete revolution of the belt, which is much less frequent than any other dynamo or motor sound, and can be seen or easily counted.

REMEDY.—Endless belt or smoother joint in belt. A perfect joint and a straight, smooth belt are always very desirable for dynamos and motors.

7. Cause.—*Slipping of belt or pulley due to over load.*

Symptom.—Intermittent squeaking noise.

REMEDY.—Tighten the belt, or reduce the load. A wider belt may be required.

8. Cause.—*Humming of armature core teeth (if any) as they pass pole-pieces.*

Symptom.—Pure humming sound less metallic than No. 5.

REMEDY.—Slope ends of pole-pieces so that armature tooth does not pass edge of pole-piece all at once. Decrease the magnetization of the fields. Increase the cross section or capacity of the teeth, or reduce that of the body of the armature.

THE AVERAGE LIFE OF INCANDESCENT LAMPS.

BY

Horatio A. Foster

In the majority of central electric lighting stations, and in many isolated incandescent plants, considerable care is taken to determine the average life of the incandescent lamp.

While this is a comparatively easy matter in the smaller isolated plants for factory use, where all the lamps are started at once and stopped at the same time, it is by no means so easy for larger isolated plants, such as those in office buildings; and it is especially difficult in central stations.

In many places an exact record is kept of each and every lamp; it is dated and recorded when sent out, and entered again on the same books when the collar is returned. While this gives excellent data for learning which installations use the larger proportion of lamps, and thus for locating possible faults in distribution, it has not the slightest bearing on the point in question, *i. e., the average life of all the lamps.*

The fact that a lamp was sent out to a place on a certain date and returned a certain date, the circuits being started and stopped at set times during that period, gives no data of value for the purpose, as, in the first place, no allowance can be made for the fact that this lamp may not have been in use at all during that time; and, secondly, it makes no allowance for lamps which, being structurally weak, burn out almost immediately.

There seems to be no way that is perfectly and positively accurate and will apply alike to all situations, but probably the nearest approach to it is by keeping an accurate station record of ampere-hour loads and the number of lamps for renewals. Ampere-hours must first be reduced to lamp-hours; then a proper percentage of reduction must be made for the predetermined average loss in distribution. This leaves the net amount of burning in lamp-hours.

It would be unfair to try to make an average on a station where the lamps had just been installed in lump, as only those lamps which were weak would come out for a long period, and, when that time arrived, the breakage would be much above the normal. It is only after the plant has been in operation for some time, and there are only occasional additions, and the lamp renewals have become a settled and steady number, and vary very little week by week, that a proper test can be made. As long a period as possible should be taken in order to give a fair average all around. The average lamp-hours per day should be found, as well as the average number of lamps connected to the circuit, also the average hours per day for each lamp connected. Then the average lamp renewals per day must be found for the same period, and the average number of lamps connected, divided by the average renewals per day, will give the number of days' life per lamp, and this multiplied by the hours per day per lamp, as found above, will give the average life in hours.

While the above method is not new, and may be in more or less constant use, it is thought well to call attention away from the old methods, which cannot possibly give accurate data.

It is well to bear in mind also that *great length of life is not the only requisite* of a good incandescent lamp.

THE LIFE WORK OF RANKIN KENNEDY.

BY

Franklin Leonard Pope

IT gives me much pleasure to present the readers of THE ELECTRICAL ENGINEER with an excellent portrait of the Scotch electrical engineer, Mr. Rankin Kennedy, who has become well known in this country by reason of his important work in connection with alternating current distribution. Mr. Kennedy is one of those men who have won success in life almost solely through their own industry and perseverance, a class of which perhaps fewer examples are to be found in Europe at the present day than in our own country.

At the age of 14, young Kennedy entered upon an apprenticeship of six years in the works of Andrew Barclay, the well-known Scotch engine builder, during which time he was employed mainly in the construction of machinery of a heavy character, such as mine pumps, blowing-engines and locomotives. During his apprenticeship he diligently improved his spare hours by attending one of the Government science schools, intending ultimately to qualify himself as a science teacher. At the expiration of his apprenticeship he was fortunate enough to be awarded a scholarship worth £75 per year, under the Government Science and Art Department, which enabled him to attend the classes at South Kensington, London. Here he improved his enlarged opportunities with the diligence and industry characteristic of his nation, and succeeded in carrying off first-class honors in the department of Electricity and Magnetism. He also obtained high certificates in Applied Mechanics, Steam and Physical Science at the Science and Art examinations on these subjects.

Rankin Kennedy

In 1872 Mr. Kennedy received an appointment as teacher in his favorite branches of physics, in the New Academy and in the Kay schools, in Kilmarnock, Scotland, which position he filled most acceptably for eight years. He first became especially interested in the dynamo-electric machine while attending the celebrated exhibition of the Loan Collection of Scientific Instruments at South Kensington, in 1874. This exhibition was particularly valuable to students, as it embraced the original experimental apparatus of many of the founders of modern science; the apparatus used by Faraday in his "Experimental Researches," including his historical ring-transformer, together with the appliances made and used by Volta, Galileo, Galvani, Davy and many others. There were also Gramme and Siemens dynamos, the latter working a large arc lamp. The Science and Art Department, with commendable forethought, invited a number of its most successful teachers from different parts of the kingdom to spend a week at this exhibition, paying their expenses meanwhile. Mr. Kennedy was one of the fortunate recipients of this honor, and it is scarcely necessary to say that he made the most of the unusual though well-deserved opportunity which had fallen in his way. Almost the first thing after his return from this exhibition, he constructed a dynamo-electric machine of the Siemens type, and also a model electric tram-locomotive with a Gramme armature.

Resigning his occupation as a science teacher, in 1880, and commencing business on a moderate scale in Glasgow, in the commercial manufacture of dynamos, motors and arc lamps, Mr. Kennedy soon began to acquire a reputation for the structural excellence and good working qualities of his productions.

Mr. Kennedy's commercial work has always been very largely in the line of isolated plants, of which he has constructed a great number, especially for marine purposes. One of the most successful of his direct-current machines was introduced in 1887, under the name of the "Single Bobbin Constant Pressure Dynamo," of which a very large number have been installed. The inherent excellence of the design of this machine is perhaps sufficiently attested by the extent to which its substantial features have since been adopted by other manufacturers, both in Europe and America. During the past five years Mr. Kennedy has executed contracts for the electric lighting of more than 120 steamers. The first large factory building in which both the lighting and the power are electrical, was engineered by Mr. Kennedy at Leeds, and his establishment is at present engaged on the largest contract yet undertaken in Scotland—the new lunatic asylum at Harwood, near Glasgow.

The most important and permanently valuable line of work in which Mr. Kennedy has been engaged is that which relates to the development of alternating inductive systems of distribution and apparatus, to which he has devoted a large share of attention since 1881. An extended series of original researches was begun by him in that year, which resulted in establishing beyond controversy, many facts and principles having a most important bearing upon the reactions involved in the transfer of energy by induction between primary and secondary conductors, which had hitherto been enveloped in obscurity. He showed among other things that the counter-electromotive force set up in a coil traversed by an alternating current and surrounding any iron core is proportionate both to the mass of the core within determinate limits, and to the length of the wire; that under such conditions a counter-electromotive force is set up in the primary wire of an inductor, and that the alternating currents induced in the secondary tend to oppose and delay this counter-electromotive force. Mr. Kennedy also demonstrated for the first time, that in the case of an endless core of sufficient mass the necessary loss of energy in conversion was very small; and most important of all, he discovered and pointed out that a system of inductors with their primaries arranged in parallel and with translating devices in their secondaries, constitute a theoretically perfect self-regulating system for the distribution of electrical energy. It is not too much to affirm, that the commercial practicability of the modern system of electrical distribution by alternating currents and transformers, is founded almost wholly upon principles discovered by Kennedy in these investigations, and first made known by him in the columns of a technical journal in the summer of 1883.[1] Prior to this time, the efforts which had been made to effect the commercial distribution of electricity by inductive apparatus, had been successful but to a very limited extent, owing to the imperfect understanding which prevailed among electricians of the nature of the reactions of periodic currents.

Shortly after this time, a protracted and serious illness for a considerable time interrupted Mr. Kennedy's work, but in 1886 he again resumed his alternating current investigations by designing the original of the well-known type of alternating machines, known as the "iron-clad," a name which, by the way, was of his own coinage. He also originated the important system of distribution by alternating currents over long distances, employed in the Frankfort-Lauffen plant, in which main transformers are employed to raise to any required extent the potential of an induced current originated by a low-pressure dynamo. Other inventions made by him during this period are subdivided transformers, and a method of measuring alternating currents by low pressure voltmeters combined with transformers having an accurately known ratio of conversion.

Mr. Kennedy is now engaged in working out the details of a new method of electrical distribution by two independent pulsating currents alternating in quadrature, which is a radical departure from present practice, and bids fair to have an extended field of future usefulness. He has also recently designed a new type of alternator, having only two exciting and two generating coils, and being without any moving coils whatever. This apparatus is capable of producing alternating currents of any required pressure and frequency however great. Another important recent invention of Mr. Kennedy is a special type of alternator for lighthouse and marine use, which has neither commutators, brushes nor sliding contacts of any description; he thus expects to eliminate nearly all the troubles that beset the dynamo under these most exacting conditions.

Mr. Kennedy has during the past ten years contributed numerous articles to the technical and scientific press of Great Britain, mainly having reference to periodic and alternating current work. A little treatise on "Electrical Distribution by Alternate Currents and Transformers," which he published in 1887, and was the earliest work on this subject, met with an extraordinary sale, the whole edition having been disposed of within a few months. A second edition is now in preparation. He has also made inventions of much merit in the line of alternating motors, meters and heating apparatus, which lack of space compels us dismiss with mere mention.

Mr. Kennedy has recently greatly enlarged his manufacturing facilities, having established himself at the Carntyne Electric Works, at Shettleston, Glasgow, which bids fair to become one of the leading electrical manufactories of Great Britain.

A NEW BATTERY FROM BAVARIA.

A Munich inventor has produced a modified battery cell resembling an ordinary Leclanché in which the carbon of the latter is replaced by copper in sulphate of copper, the zinc rod being in salammoniac. There is a special modification in the porous pot itself, which is prepared by dipping it, to one-third of its height, into melted paraffine wax, and then filling it with an aqueous solution of ammonia. The ammonia solution is then poured out and replaced by copper sulphate, which is in its turn poured away, and, finally, the pot is allowed to drain dry. The object of this successive dipping into ammonia and copper sulphate solutions is the formation of a double sulphate of copper and ammonium which fills up the pores of the cell, and being insoluble in either of the solutions used in the battery, prevents them from mixing.

1. London *Electrical Review*, June 9, 1883; ibid; June 16, 1883.

THE ACCUMULATORS AT THE FRANKFORT ELECTRICAL EXHIBITION.—I.

BY

Paul Schoop

The electrical accumulator is considered on the European continent and in the United States of America from widely different standpoints. Since the storage-battery has been introduced into this country its biography has been an uninterrupted tale of woe and sorrow. This has been not only in the United States; the English electricians have also had the most discouraging experiences. It is, nevertheless, a fact that in Germany, Austria and Switzerland quite the reverse is the case, the most celebrated electricians there favoring accumulators, and as a consequence using storage batteries for central station lighting to a large extent. We may state that the well-known Siemens & Halske Co., of Berlin, have not erected central stations without a storage-battery plant for some time past, and that the two most important accumulator factories, at the Oerlkon Works, in Switzerland, and at Hagen, in Germany, have filled very large orders during the last two years. The exhibition at Frankfort impresses the fact upon one that the accumulator business is being pushed in Europe.

It may be interesting to look at the reasons of this very different state of affairs between the two continents. Consider first the fact that in Europe, and especially in Germany, the lead accumulator has been mainly adapted to lighting purposes, while in America it has been tested principally with a view to street car work. A great many people here are already of the opinion that accumulator cells are out of question for the economical working of street cars. Probably there are a lot of people of the same opinion in Europe, too, but there are in Germany more electricians who consider the leaden storage battery

Fig. 1.

of to-day a necessary and practical apparatus for central stations, and perhaps a smaller number who look forward to accumulator cars also. It seems doubtful at present which is right. Let me first state that, dealing with the storage batteries exhibited at Frankfort, one receives the general impression that the manufacture of the cells, as well as the erection of the whole plant, is performed in an infinitely more careful manner than was the case only two years ago. The manner of connecting the electrodes, binding the cells together, and the complete arrangements for automatically avoiding overcharging, etc., are of the greatest perfection, and, though the chemical part of the lead cell has been pretty well cleared up in regard to the conditions of the longest possible life of the electrodes, it is well known that the careful erection and handling of a plant are even more important with storage stations than with dynamos or motors. In some places the opinion prevails that the failure of storage batteries in this country depends partly upon the lack of these conditions. In each case, if a prediction is allowed here, we may be bold to say that after some time the accumulator will again be introduced here, and, let us hope, in a more favorable way than formerly.

It seems that of the two original types of lead accumulators, to wit, the Planté type and the Faure type, the Faure type alone has been developed of late, as no cells without paste or mechanical application of active material are to be found at the exhibition, and no secondary batteries of other material than lead are present there. There is enough variety among these leaden batteries, however, and in trying to give as exact an account of them as possible we shall here classify them according to the method of manufacture of the electrodes.

We find that the supports for the lead oxides are made by casting, by hydraulic pressure, and by rolling sheet lead, and that either dilute sulphuric acid or gelatinized acid is used as an electrolyte. Cast lead grids are exhibited by G. Hagen, Köln, Germany, Correns & Co., Berlin, and the Deutsche-Accumulator Actien-Gesellschaft.

Usually the grids are cast by means of iron or brass moulds, and this plan has been continued by Correns & Co. and the Actren-Gesellschaft, while G. Hagen casts in

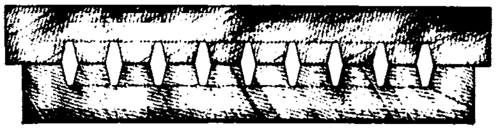


FIG. 2.

the same or a similar material. Considering the old type of plates, as manufactured by the well-known accumulator companies in this country, we find a grid forming a network of lead bars, which have a cross-section, as indicated by Fig. 1.

Fig. 2 shows the metallic mould used in casting such a grid. The form of the plugs of active material is shown at *b*, Fig. 1, and if such a plug splits, as occasionally happens, the two halves are liable to fall out of the grid.

WHO SHALL DO THE WIRING?

BY

A. E. BRADDELL.

I HAVE read the article bearing the above title by Mr. C. A. Harris in the August 26th issue of THE ELECTRICAL ENGINEER with a great deal of interest. As my duties consist in inspecting electric wiring, I feel that I should have something to say on this subject.

The question can be answered with many pros and cons from both sides, but as far as my experience goes, it depends altogether on the location of the city or town, who shall do the work. By this, I mean that in nearly all the large cities the contractors are, for the greater part, responsible men, and as an inspector is generally employed, he can weed out the good from the bad. Now, take the case of a small town at a distance from a large centre of population, and where it will not pay to have one of these contractors wire for, say, a dozen lights at a time. Now, if the local lighting company does not do any work, not even repairing, it follows that the amateur electricians (cheap Johns) see a "bonanza" in sight, and are not slow to "catch on." This is where I find the work, as Mr. Harris puts it, "fearfully and wonderfully done," not only jeopardizing property, but casting a blot (and that a very black one) on the name of the electric lighting company.

These men know little about this class of work, and if asked how they learned the business, I think the answer would be like unto the Irishman's "Sure I did it by my own penetration." Of course, this work is principally found where the electric company does not give any supervision to it, but simply furnishes current wherever and whenever asked.

Next with regard to companies that make the wiring a "secondary consideration." Of course, there were many who had to make some inducement in the early days of the business, and therefore wired numerous places without charge. This method of getting customers is, I think, or at least hope, being abandoned, as people see that electricity is getting on such a firm basis that it can hold its own with any other illumination without free wiring.

Apropos of this, I heard the manager of a large central station state to one of his customers not very long ago, when speaking about rewiring a risk, that he "used to run a free lunch counter, but now all the soup was gone," and that the customer would have to pay for what he got. But, as stated before, the worst trouble is found where local contractors do the work. I contend that the electric light companies, especially those in the small towns, should do their own wiring. By getting a good man and paying him a decent salary, I am certain it is money in their pockets. Take a building wired by an outside person in a small town, and let there be a fire caused from defective wiring. The owner of this building is not going to trouble himself about the exact why and wherefore of the fire, as he expected and paid for "a first-class job," but he immediately pours out his wrath in the form of violent execrations against the electric company. Now, why should they suffer for another person's sins? The owner of the building simply thinks that the electric current cannot be properly controlled, and therefore dispenses with the light.

I do not wish it to be understood that no work should be done outside of electric light companies. Far from it. I am a believer in the motto "Live and let live," and my object is simply to keep out incompetent and irresponsible men. With this object in view, it may be of interest to state the method adopted by the Association with which I am connected. The different electric light companies are asked to sign an agreement stating that "all work will be made in accordance with the rules and requirements of the Association, and that any defects found will be corrected in accordance with same." Another clause which we look upon as very essential is as follows: "That the electric current will not be supplied for any work done by other parties unless such parties have made a similar agreement, or furnished a certificate from the electrical inspector that it is approved." I would state that sixty-seven of these agreements have been signed by lighting companies, and eighteen by contractors, in our territory. By this means we know the people who are, or should be, doing the work, and are able to keep track of them. This appears to be a good method of working where there is a large territory to cover, as it is impossible to inspect every little "shanty" as it is wired. Of course, that is what should be done, but expense is the great drawback, at least if it has all to be borne by the insurance companies. Mr. Harris speaks of a town where "the wiring was given over entirely to local contractors." I venture to state that the work done was as bad as, if not worse than, that by the electric light company before the appointment of the city electrician. I will conclude by seconding the motion of Mr. Harris, that a general expression of opinion on this subject be given through these columns as affording the best means for a thorough ventilation of this important subject.

TROUVÉ SEA-WATER BATTERY.

THE indefatigable M. Trouvé has been astonishing the French Academy of Sciences by his design for an electric boat propelled by a sea-water battery. The plates are sunk in the sea under the boat by way of a kind of keel, and drive a large rotary wheel by means of a motor. Pulleys raise or lower the plates of zinc or copper, as required. Thomas Davenport, the Vermont blacksmith, whose career was recently set forth in the pages of THE ELECTRICAL ENGINEER, made a similar suggestion or design fifty years ago.

THE ROBERTS CHROME ARC LIGHT PENCIL.

BY

Isaiah L. Roberts

IN the history of the electric arc pencil, begun with Sir Humphry Davy and his charcoal points, it was soon discovered that the carbon deposited on the inside of gas retorts in the process of manufacturing coal gas by the destructive distillation of coal, was a conductor of electricity, and made better points than charcoal for experimental purposes. Later, when it was proposed to use the electric arc commercially, it became necessary to manufacture pencils which would be capable of "feeding," and this gas coke was employed as the best material. It was pulverized and mixed with some substance containing a large amount of carbonizable material, which would become plastic when heated, and thus a mass could be made which could be moulded into the desired form and size.

These pencils must be baked in a retort until enough hydrogen and water has been driven off to make the remaining carbon a conductor, and bind together the original coke. In the early state of the art they were very poor conductors because of the great heat needed to completely carbonize the binder, generally asphalt or bitumen, which are fine insulators. They were also soft and not homogeneous.

These defects caused them to burn rapidly, and, with the poor lamps used in the early days of the arc light, to give a sort of winking, jumping light that was most trying to the eye. Thanks, however, to the inventor, both the mechanism of the lamp and the pencil have been so improved that a brilliant and steady light can now be produced.

Very soon after the introduction of the arc light it was found to be impracticable to make pencils of such a length that one pair would burn all night. This resulted in the use of the double arc lamp, so that now all-night lighting is possible.

The double lamp is about twice as expensive as the single lamp, and constitutes no small item in the cost of the plant. To avoid this expense many inventors have busied themselves for several years with the problem of finding something which could be mixed with carbon that would prolong the life of the pencil. Others have tried "tipping" the pencils with some refractory compound. Others still have tried making them of metals, combinations of metals, or oxides of metals, but nothing has been produced which did not have some objections fatal to its utility.

The initial letter of this article shows a pencil which is free from all serious objections and promises to revolutionize the art of electric arc lighting.

This pencil is composed of nothing but the simple elements of iron, chromium and oxygen. If a piece of iron wire be coated or a tube be filled with a chromate of any kind it becomes at once a suitable electric arc pencil. Probably the best form is that shown in the illustration. This is a piece of wire cloth rolled into a cylinder of any size or length, the meshes holding the chromate firmly in position.

The principle on which the pencil burns is as simple to understand as its construction. The chromates are non-conducting bodies, but the metal starts the arc when the pencil separates, and the intense heat thus generated reduces the chromate in presence of molten metal to the chromite of the metal used. These chromites are good conductors when hot, and fair when cold. This enables the pencils to relight.

One of the chief difficulties of using any metallic compound was the relighting. For instance, if an iron tube be filled with lime a good light will be maintained so long as the ends are hot, but when once cold they cannot be relighted, because the slag of iron oxide and lime is a non-conductor. But with chromium oxide and a metal, a slag is formed which will conduct when cold. A little carbon mixed with the chromate helps to reduce it.

The light from these pencils is normally pure white, like the calcium light, but it may be made of any color by introducing various coloring ingredients into the chromate. The actinic rays are more powerful than in a carbon light, while the most delicate colors are brought out fully as clearly as by sunlight. The faintest yellow, which cannot be distinguished from white by carbon light, is readily discernible. These pencils burn about $\frac{1}{8}$ of an inch per hour when properly proportioned to the current. Thus a pencil consuming one and a half inches will burn all night. The light is very steady; so much so that it very much resembles the incandescent light, which in fact it really is to a great extent. This steadiness is due partly to the fact that the mechanism of the lamp is required to operate so seldom that this factor of disturbance does not count.

Another marked peculiarity of these pencils is that the arc with 45 volts is about $\frac{3}{4}$ inch long, while the same E. M. F. with carbons makes an arc of only about $\frac{1}{8}$ inch. When the arc made with carbons exceeds $\frac{1}{8}$ inch, or when it reaches so much as $\frac{1}{4}$ inch, the light is very unsatisfactory, and is called a "flaming" arc. With the chrome pencils the light comes principally from the flame. This is due largely to the small particles of ehromite volatilizing in the intense heat of the arc. The length of the arc and its flame-like nature resembles the flame of a candle, and like it, cannot stand any strong air currents, and hence must be enclosed in a globe as nearly closed as is necessary to prevent draughts.

One of the greatest points of difference between chrome and carbon pencil lights is that with carbon no practical lighting has been accomplished with less than five amperes. The reason for this is that the size of the carbon pencil must not be reduced beyond a certain size, or it will consume too rapidly. If it is not reduced, currents of two or three amperes will not heat the point sufficiently to centre the arc. With chrome, however, the pencils can be made so small as to reach the heat intensity necessary with almost as great economy with a current of one or two amperes as is obtained with ten. As much as 100 actual candle-power, or 300 as commonly rated, can be obtained with two amperes and 50 volts with a consumption of $\frac{1}{4}$ inch per hour, the consumption being about double that of a pencil suitable for a current of six amperes. There is no gain in using large currents and large lights when a greater number of smaller lights break up the shadows more effectually, and make a more acceptable arc light, especially for inside lighting.

Like all revolutionizing inventions, some changes must be made in the present form of this pencil before it can be properly used. The lamp must accommodate at least a half-inch arc, and the arc must be in a globe tight enough to prevent air draughts sidewise. Any lamp using this pencil must be provided with a retarding device, so that when the circuit is broken or the current stopped the pencil will not be allowed to touch for a space of four or five seconds, for if allowed to drop together they will weld, the points being in a plastic condition. If, however, a short space of time be allowed, the ends harden sufficiently by cooling. The lamps used for these pencils must be provided with a shunt of a few ohms resistance, as it takes from 6 to 12 volts to start sufficient current through the feebly conducting ends to heat them. The instant they warm up, however, they have practically no resistance. Carbons have high resistance at the incandescent ends when burning, but no resistance when cold. The chrome pencils are just the reverse.

THE EFFECT OF ELECTRIC LIGHT ON PLANTS.

THE experiments at Cornell University, on the effect of the arc light upon the growth of plants under varied conditions, have developed results sufficiently remarkable to attract the attention of horticulturists and electricians alike, and proved that the subject was one demanding careful investigation.

FIG. 1.—EFFECT UPON VERBENAS.

The forcing house used in the Cornell experiments was 20 x 60 feet, with a low, flat roof, ventilated by windows at the peak, and heated by steam. This was divided by a board partition, one-half being subjected to natural conditions of light and darkness, and the other receiving sunlight by day and electric light during the whole, or a part, of the night, the arc being 2½ feet above the soil of the bench. The lamp used was a 45 volt 10 ampere Brush, of 2,000 candle power.

The general effect of the naked light running all night was to hasten maturity, especially in the case of leaf plants, such as lettuce, spinach, etc., which ran to seed before edible leaves were formed. For five feet either side of the lamp the plants died soon after coming up. Two varieties of cress acted in the same way, and the surviving plants were in full bloom seven weeks after sowing, while those in the dark house were still in good leaf.

Radishes were injured by the light in direct proportion to their proximity to the lamp, those within three to six feet being nearly dead at the end of six weeks.

In regard to entire crops, it was found that those obtained in the normal house were about twice as great as those from the light compartment.

Tests were then made with a view to discovering whether the injury to the plants resulted from the electric light itself or from the fact that they received light during the whole twenty-four hours. The plants were covered during the day in such a manner as to entirely exclude the light, while permitting a free circulation of air. Radishes, subjected to this treatment, were slender and sickly, assumed a faint green color, and died in three or four weeks.

FIG. 2.—EFFECT UPON PETUNIAS.

The fact that the light hastened seed-bearing suggested that a modification might, under certain conditions, be profitable, and to this end the lamp was enclosed in a white "opal" glass globe. The results were very much the same, but in a less degree, with the exception of the lettuce, which was decidedly better in the electric light house.

The influence of the light upon productiveness and color of flowers was found to vary with different species and with different colors within the same species. Several varieties of tulips gave interesting results. Careful observations were made upon Proserpine, light-cherry color; Wourseman, maroon; Vander Neer, light cherry; Yellow Pottebakker, bright yellow; Belle Alliance, scarlet; and Cerise gris delin, cherry and white. When these came into full flower it was found that in every case the colors were deeper and richer in the light house; but the colors lost their intensity after four or five days, and were indistinguishable from those in the dark house. The plants in the light compartment had longer stems and larger leaves than the others; and there was a greater number of floriferous plants in the light.

Verbena flowers growing near the electric light were uniformly injured. All plants within six feet of the light were stunted; the leaves were small and curled, and the flowers were short lived. The flowers were small, and those on the lower part of the clusters turned brown and died before those on the top opened. The buds within two or three feet of the lamp curled up and shrunk and became discolored before opening, but the discoloration did not extend to the inside of the flower until it had opened. Scarlet, dark red, blue and pink flowers within three feet of the light soon turned to a grayish-white, and this discoloration was noticeable to a distance of six or seven feet. The plant shown on the left in Fig. 1 of the accompanying illustrations was subjected to the electric light, while the other was raised under normal conditions, and it will be seen that the former is past flowering, while the latter is in good condition.

Petunias were much affected by the light, as is shown in Fig. 2. The plants were much taller and slenderer, and bloomed earlier and more profusely. Those marked A B C grew 14 feet from the light, and D E F in the normal house. The flowers faded from the effect of the light, however, and became thin and flabby.

From these and other experiments, it seems highly probable that while, in a variety of instances, the effect of the arc light is injurious to the proper growth of plants, yet under certain conditions the judicious use of the electric light will prove particularly helpful. The study is an instructive one, and will, doubtless, be productive of important results.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—XVI.

BY

Chas. Steinmetz.

THIS is of less importance for parallel transformers because all the commercial transformers must, on account of the heat generated otherwise in the iron, work with a magnetization, shown in Fig. 28 by the dotted line *I*, considerably below the maximum point of impedance, so that still a considerable increase of impressed E. M. F. could be allowed, without fear of magnetic breakdown.

Only under abnormal conditions this phenomenon becomes of dangerous importance. For instance, if by mistake a 100-volt converter is connected "upside-down," that is, with its coarse wire terminals, to a 1,000-volt circuit, then the leakage current will not only be increased ten-fold, as constancy of magnetic susceptibility would lead us to expect, but the converter will short-circuit the dynamo.

If the frequency is decreased considerably, and the impressed E. M. F. kept the same, with a certain frequency, the danger point, marked on the diagram, Fig. 28, will cross and b_1, that is, b_s, will be reached. This point corresponds to the turn in the magnetic characteristic.

But this phenomenon has a reverse, which might be made useful in constant current transformers. If in Table I, corresponding to Fig. 27, the primary current is kept constant at 58.1 amperes, for a secondary current of 36.9 amperes the transformer consumes 92.4 volts primary E. M. F. But, when breaking the secondary circuit, the E. M. F. consumed by the transformer goes from 92.4 volts down to 85 volts. Hence in constant current transformers this phenomenon could be used to guard against too great an increase of impressed E. M. F. at open circuit.

X. Non-Sinusoidal Waves.

Having considered in the foregoing the harmonic or sine-wave in its action upon the closed-iron transformer, we need to add only a few remarks on non-sinusoidal waves, because these currents have not found until now any extensive application in electrical practice. The waves of all the alternating dynamo electric machines under almost any circumstances are either so nearly harmonic or sine-waves, that they can be considered as such without hesitation, or, even if they differ very considerably in their shape from true sine-waves, nevertheless the assumption of sinusoidal shape generally gives a remarkably fair approximation.

For instance, in the Westinghouse transformer, treated in the next chapter, the primary current, especially for open secondary circuit, differs very considerably from a harmonic wave. Nevertheless we shall see how closely the phenomena observed with this transformer are represented by the polar-diagram of sine-waves. But, if we represent electric waves of different shapes by sine functions, we shall have to define first what is meant by the *phase* of the wave.

As the phase φ of the wave we consider the angle—that is, the time—which divides the wave into two halves of equal *effective* strength, so that the average value of the *square* of the current, etc., from its zero value up to the value corresponding to its angle of phase, equals the mean *square* of the values from the angle of phase down to zero again. That is, *the phase of the current, etc., is that angle φ, which divides the area of the curve of the electric wave in the polar-diagram into two equal parts.* This generally does *not* divide the area of its representation in *rectangular* co-ordinates into two equal parts.

As *maximum value* of the electric wave is used in the diagram, the product of the effective value, that is, $\sqrt{\text{mean}^2}$ into $\sqrt{2}$, or the diagram is produced directly by using the *effective values* of the electric quantities as the diameters of the polar-circles, instead of the *maximum values*, which gives the same result, only that then, if we want to take *instantaneous values* from the diagram, we have to multiply the radii vectores by $\sqrt{2} = 1.4142$.

In the following chapter, in the diagrams of some commercial transformers, we shall proceed in this way.

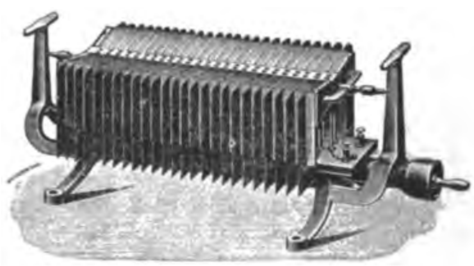
GULCHER'S THERMOPILE AT THE FRANKFORT EXHIBITION.[1]

THE Gülcher thermopile is now constructed by the well-known firm of Julius Pintsch, of Berlin, in two sizes. The accompanying illustration represents the larger model of the latest type manufactured. It has a weight of about 10 kilogrammes, and consists of 50 elements, mounted in two parallel rows on a slate plate. The slate plate forms the cover of the gas reservoir place beneath it, which is provided on the right-hand side with a Bunsen supply pipe. Each element consists, in the first place, of a small nickel tube, forming the negative electrode, and at the same time serving as a supply tube for the Bunsen flame. To the upper end of the nickel tube, into which a simple jet burner of serpentine is screwed, a tubular connection-piece, also made of nickel, is strongly soldered. About this latter the positive electrode, consisting of an antimony alloy, difficultly fusible and very durable, is cast. As a protection against mechanical changes of the alloy (rent, cracks, etc.) which might arise from the expansion of the heated junction tube, and would increase the internal resistance of the element, two steel rings are laid round the junction pipe. At the external extremity of the positive electrode copper sheets for cooling purposes are soldered, serving at the same time for the connection of the elements. All the elements are insulated from one another by asbestos, and the space between the heated places of the elements is lined with the same material.

The remarkable feature of this thermopile is, in addition to its great durability, its great efficiency, greater than has hitherto been obtained by any similar apparatus. The model represented in the figure gives an electromotive force of 4 volts. Its mean internal resistance is .04 ohm, so that (with an equal external resistance) a thermopile of this kind gives a current of 5 amperes.

The working expenses of the larger type, therefore, amount to about 3 pfennigs (a little more than ½ cent) per hour. It further follows from this that the Gülcher thermopile, per cubic meter of gas, gives a total electrical energy of 100 watts, whilst the best instruments of this kind hitherto constructed only give about 24 watts per cubic meter of gas.

A still higher efficiency than the batteries heated by gas is shown by the batteries intended for the production of



GULCHER'S THERMOPILE.

large electrical energies, and arranged for *heating with coke.* In these, the elements are grouped round a common stove, and other improvements have been adopted, increasing the efficiency. One of these improvements is as follows: The terminals of each element are joined in such a way, by an intermediary contact replacing the solder, and are so arranged that the difficultly fusible electrode (nickel) is heated much more than the more easily fusible electrode (antimony alloy). The advantage obtained by this arrangement is, in the first instance, that the elements themselves cannot fuse by excessive heating; on the other hand, that the internal resistance is reduced by more than one-half. From this it follows that the elements (at equal temperature and E. M. F.) generate a current twice as large as those of the old-fashioned type. The second essential improvement permits the perfect utilization of the heat of the common stove for the purpose of conversion into electricity. This object is obtained by making constant in each row of elements built up to form the battery the ratio of the external resistance of the element to the E. M. F., it reaches at a certain part of the stove.

A thermopile consuming 2 kilogrammes of coke per hour gave 80 volts and (at equal external and internal resistance) a current of 10 amperes. The useful output of such a battery would thus amount to 400 watts and suffice for feeding 8 glow lamps of 14 to 16 candles continually, or (with the help of accumulators) 30 of these lamps for six hours per day.

MR. E. R. MITCHELL, of the Thomson Houston factory, Lynn has gone to Minneapolis to take charge of the repair department of the Northwestern Thomson-Houston Co.

1. London *Electricity.*

THE "JOULE," "746" AND THE "WATT."

BY

G. T. Evans.

Unfortunately, to adequately discuss this subject, it seems necessary to pass over ground which bears the footprints of many a worker, and which would, it almost seems, be wholly gleaned and devoid of any remaining material. The main excuse I have to offer for turning over this soil again is that a majority of "electricians" are still not conversant with the subject; many do not know the definite relations which exist between the above units and other units of Power and Work, and not a few are unaware of how easily these relations may be traced to a common root.

The joule, the watt and the constant, 746, are terms common enough in these days, but there are very shady ideas abroad concerning them. Even the more common volt is sadly misrepresented, and only recently the superintendent of a large station refused to connect a motor because the fuse looked "too small to carry 220 volts."

The utility of the knowledge of the "stuff these different units are made of" and their connection with each other for any but the theoretical electrician may be questioned. A man without this knowledge can squirt oil on a bearing or splice a wire as well as one who possesses it. This may be so, but squirting oil, splicing wire and such necessary work should not form the sum total of his knowledge. He ought at least to have enough respect for his business to be able to converse sensibly on it. A poor carpenter would he be who would not tell what an inch is, or a tin-smith who was ignorant of the size of a quart. Yet there are hundreds of "electricians" who cannot state the difference between an ampere and an ohm.

As a reference to what will be said of the joule, watt and 746, the following familiar formulæ are inserted:

$$W = P \times T = \frac{E^2 \times T}{R} = E \times Q = R + Q^2$$

$$P = \frac{W}{T} = \frac{E^2}{R} = E \times C = R \times C^2$$

Where W = Work; P = Power; E = Electro Motive Force; T = Time; R = Resistance; Q = Quantity; C = Current.

Unit	of	W	in	electro	magnetic	measure	Joule.
"	"	P	"	"	"	"	Watt
"	"	C	"	"	"	"	Ampere
"	"	Q	"	"	"	"	Coulomb
"	"	R	"	"	"	"	Ohm
"	"	E	"	"	"	"	Volt

Horse-Power = 550 foot pounds per sec.; 746 joules = amount of *work* done by 1 h. p. in *one second*; 746 Watts = 1 h. p.

Units of the same dimensions but of different denominations must be reduced to a common denomination to determine what part one is of the other. According to the formulæ, the joule being the product of volts and coulombs, and supposing for simplicity that each of these factors is equal to unity, the next step is to reduce these factors to absolute or C. G. S. units. One coulomb = .1 of the absolute unit of quantity. One volt = 10^8 times the absolute unit of electromotive force. The product of 1 coulomb and one volt thus reduced 1×10^7 absolute units of work = 10^7 ergs. A mass of 1 gramme raised against a force of 1 dyne through a distance of one centimetre has 1 erg of work done upon it. Since the force of gravity is, in round numbers, equal to 981 dynes, a gramme mass will, when raised 1 centimetre, have 1×981 = 981 ergs done on it. One gramme centimetre is thus equal to 981 ergs. In a foot there are 30.48 centimetres, a centimetre being equal to .3937 inches.

In one pound there are 453.6 grammes, there being 15.432 grains in a gramme and 7,000 grains in a pound. Multiplying the factors of the foot-pound thus reduced, the product of 13,825.82 gramme centimetres is obtained. As 1 gramme centimetre = 981 erg, 13,825.82 gramme centimetres is equivalent to 13,563,125.88 ergs. The number of ergs in one joule, divided by the number of ergs in 1 foot pound will give a result of .7373, showing that 1 joule is .7373 of a foot-pound. If the foot pound be increased to 550 foot pounds, work of 7,459,719,245 ergs will be done, which is approximately 746 times the number of ergs in 1 joule. If this work is done in 1 second, it would be at the rate of 1 h. p., and the work done by the joule would be at the rate of $\frac{1}{746}$ of a horse-power, or at the rate of 1 watt.

Perhaps the most interesting way of tracing out the relation between the joule and foot pound is by a process derived from the well-known "Joule" experiment of heating water by a revolving paddle-wheel. It was found that the wheel being revolved in a pound of water by a falling weight equal to 772 foot pounds, would raise the temperature of the water 1° Fahrenheit; 550 foot-pounds acting upon the water would raise the temperature .7124° F.

A current of electricity delivering 1 joule to the water would raise the temperature .00095508° F, which is $\frac{1}{746}$ of the increase caused by the expenditure of 550 foot-pounds.

A little investigation given to all the electrical units would be wonderfully beneficial, and their mystery, which in so many minds, surrounds them, would be shown to be pure, simple common sense.

ELECTROLYTIC DEPOSITION OF ORE IN FRANCE.

The French Société des Ingenieurs Civils have lately had before them a discussion upon plants supplied by power from the falls of Valloirette at Saint-Michel, Savoy, which are being established by M. Adolphe Minet. The Saint-Michel works will be specially arranged for the working on a large scale of M. Minet's electrolytic processes. The power at present at disposal is 6,000 h. p., of which 4,000 h. p. is capable of being utilized. This can be raised to 30,000 h. p. Besides aluminum, M. Adolphe Minet intends to carry out the electrical extraction of other metals and metalloids, particularly those elements of which the oxides are irreducible by carbon, and for which the processes of electrolysis by high-temperature fusion, of which M. Minet is the orginator, is suitable. He intends to also develop the applications of electricity to chemistry and the refinement of metals.

GUTTA-PERCHA FORESTS.

The valley of the Orinoco, which is connected in such a peculiar manner to the River Negro by the Casicuiare, has been found to contain not only immense virgin india-rubber forests, the trees of which are said to yield a rubber superior to the best Para, but also trees of the order Sapotaceæ. Amongst the various gums obtained by explorers in the upper reaches of the river, some have been found by experts to be very similar, if not identical, with the products of the Malay Archipelago.

THE BANDSEPT ACCUMULATOR.

The accumulator invented by M. Bandsept is being introduced by the Franco-Belgian Lighting Apparatus Company. The electrodes are formed of a compressed powder, which is saturated during the process of compression by substances reduced to a gaseous state. The powder is thus impregnated, and becomes solid under continued pressure. The company is about to carry out a system of electric lighting on the smaller lines of railway by means of this accumulator.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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Science is a growth of time, and though man's cultivation of the field is an essential condition of that growth, the development steadily progresses, independently of any individual investigator, however great his mental power.—Josiah Parsons Cooke.

THE NEW YORK UNDERGROUND ROAD.

FURTHER reports have been made to the New York Rapid Transit Commission by its engineers and others, but in nowise do they bring nearer the end to which all the inhabitants of this city are so anxiously looking. On the contrary, they are a disappointment. The plan proposed does contemplate an underground road, it is true, but the road would come so near the surface that it brings back into the problem all the old difficulties that rendered a solution impossible. The extraordinary feature of these reports, however, is that they make no mention of the Greathead system, although that is to-day the only one known and shown to be operative. In other words, the reports filed would give New York, practically, such an underground system as London has found imperfect and inadequate, and would debar us from the new methods that London has been progressive enough to try and is pleased enough with to extend and push. There has yet to be published any data or information that would condemn the Greathead tunnels and the electrical apparatus they use, and while it may be quite feasible to improve on both, little doubt can be entertained as to the enormous advance they have made in underground travel.

It has been hinted, nay, expressed loudly, that the reason why the deep-tunnel plans have been put in the background is that "there is nothing in it for Tammany," for the reason that such tunnels burrowing far below buildings, pipes and streets would avoid all the vested rights in the readjustment of which, with the plans now favored, a great many politicians would be given an opportunity to rise in world. If this be so, it would be a measure of economy to ascertain who these politicians are, get their price, buy them off, and add the money thus spent to the cost of deep-tunnel work. This would be a paying investment for the city, and far less costly than leaving these politicians to an unholy scramble for two or three years. What New Yorkers want is rapid transit, and one of the saving virtues of the World's Fair that we missed would have been the fact that sheer necessity would have brought such a boon among the Fair's developments. That the city should first be deprived of the Fair by Republican bosses, and then be robbed of rapid transit by Tammany heelers is nothing short of intolerable. But perhaps a better fate awaits the city as to rapid transit than current rumors imply.

ELECTRIC LIGHT AND PLANT LIFE.

THERE has been not a little said on the subject of the effect of the electric light on plant life; but we confess to feeling little confidence in any results obtained prior to those of the Cornell Agricultural Station, of which note is made in our columns this week. One cannot arrive, even now, at any very definite conclusion, yet it is safe to adopt the opinion of the experimenters, who say that the light promotes assimilation, helps growth and maturity, can produce natural flavors and colors in fruits, will intensify the colors of flowers and sometimes increase the number of blooms. It would follow that the light can be used with commercial profit. Yet, evidently there are some vegetables and flowers that the light is hurtful to, just as there are some human races that modern civilization acts upon as a curse.

COMMON SENSE AT FALL RIVER.

WE are glad to see that the sound common sense for which New England has a well-deserved reputation has made itself felt in the deliberations at Fall River, Mass., over the proposition to establish a municipal lighting plant. The committee on street lights have carefully investigated the subject, and have come to the conclusion that the local company can give a better and cheaper service. Moreover, they say that the scheme "rests upon no adequate public demand; it will inevitably work great injury and injustice to an industry which should be fostered and not discouraged; it is contrary to sound precedent; it is impolitic because it will necessitate a vast enlargement of public service, and may lead to a great official neglect and corruption; it is inexpedient because as a business venture it will not prove of financial advantage to the city." All of which are very good reasons for not embarking on what is neatly objected to as "an experiment so vast in its proportions and so uncertain in its results." The committee are not misled by the wild figures that have been afloat as to municipal lights costing only 20 or 25 cents a night, but say that with a 200-light plant they would not be able to give service for less than 55 and 65 cents per light per night. They quote, too, the figure of 52 cents per night recently given as the cost per lamp for a proposed 1,000-light municipal plant for Boston. As the report will probably be adopted, one New England city at least may be congratulated on having the judgment not to run itself into heavy debt for the sake of engaging in commercial and industrial pursuits.

THE CHICAGO ELECTRICAL CONGRESS OF 1893.

We print elsewhere in this issue a suggestive communication from Professor H. S. Carhart, touching arrangements for the International Electrical Congress to be held at Chicago during the World's Fair of 1893. The situation of the matter is clear. It only remains, before official notices or invitations are sent out in the name of the Columbian Exposition and of the Government, to include in such invitation a proper recognition of the work already done in the same regard by the American Institute of Electrical Engineers. That body undoubtedly embraces in its membership so large a number of the most distinguished electricians and electrical engineers of the country, as to make its official recognition by the Exposition authorities and by the Government in connection with the Electrical Congress an element of strength in securing an adequate and representative attendance of electricians from abroad in 1893. We speak advisedly when we say that since first agitating the matter two years ago, the only aim of the Institute has been to make such a Congress in this country a success, and that its best efforts will be given to the authorities in Chicago. There was a time, not many months ago, when it was proposed to make the Electrical Congress an insignificant portion of a Civil Engineering Congress. This the Institute opposed resolutely. Affairs are now, however, in just such shape as will best fulfill the wishes of the Institute, and this was clearly stated at Montreal, when one of the members of the Institute committee urged the National Electric Light Association to join with the Institute in supporting the Chicago authorities and in making the Congress there a memorable event in electrical history. We are glad to receive word, just as we go to press, that Dr. Elisha Gray has accepted the chairmanship of the Committee on Electrical Congress of the World's Fair authorities. This appointment will meet the hearty approval of electricians, both at home and abroad.

Electrical Talent in the Navy.

An officer in the army or navy expects to go wherever duty calls, and hence there is nothing out of the way in the fact that Lieut. Bradley A. Fiske has been ordered to the South Pacific in the old tub "Yorktown;" but it does seem to us that such ability and experience as his in the field of electricity might be better availed of than by thus sending him to the far ends of the earth where his electrical aptitudes will have no opportunity of utilization. The United States Navy, with all its new work, needs such men at home, and it is impossible not to feel that the place for such trained electrical experts as Lieuts. Fiske and Murdock is near to headquarters and not in dim corners of the world. Moreover, in the case of Lieut. Fiske, there are one or two very important inventions that home, but have elicited very favorable comment in naval have not only excited the admiration of electricians at circles abroad. Surely it would have been easy to assign him to a ship where these inventions could have been put thoroughly to the test. What is the use of building fine men-of-war unless they have all the appliances that enable them to save themselves and smash the enemy?

"Let There Be Light."

During the past ten or twelve years we have had the pleasure of noting the installation of a good many central station plants. We are glad that the work goes on, and that part of our duty still lies in keeping up the record; but the pleasure would be very greatly enhanced if our esteemed contemporaries of the secular press would kindly stop heading their articles on the subject with "Let there be light." As there are to-day pretty well 2,000 central stations, and as each of these has had, on an average, about five articles so headed written in its honor, it follows that we have had to dally with that text about four times a day for the last ten years. We have stood this monotonous repetition of a once brilliant remark with all the strength that Christian fortitude and Jewish resignation combined could afford, but we trust it will not be thought impertinent if we ask for something fresh and novel. It is now emphatically unsafe for any man to express his belief, in a company of electricians, that "electricity is still in its infancy;" and it is also to be hoped that the hour is approaching when no self-respecting newspaper will thus preface its rich, nineteenth century American with threadbare, first century Genesis.

Baked and Boiled Criminals.

A report has now been published by the physicians who conducted the recent electrical executions at Sing Sing. It is a very unsatisfactory kind of document, but is pretty clear on the point that the current was quite successful in baking the skin and boiling the blood of the four criminals who were intercalated in the circuit to gratify the humane instincts of Mr. Gerry. The doctors assume quite gratuitously that there was neither consciousness nor pain, but it appears that in one case two doses of current of 27 and 26½ seconds' duration were necessary; in another, three of 10 and one of 19; in the third, three of 20 seconds; in the fourth, three of 15 seconds. Still "no organ was shattered or much out of order," and therefore electrical execution is all it is cracked up to be.

Electric Railway Conduits.

Interest in systems of electric railroading that shall take the current from below instead of from above has been revived by the comments of many of the papers on the Broadway cable road, and the statement by Mr. Edison that he has devised a plan for picking up the current in some way from the rails. The use of the rails is an old and oft tried idea, but if Mr. Edison has hit upon a way of rendering it available in large cities, he will have conferred a decided benefit upon the public and the electrical community.

THE INTERNATIONAL CONGRESS OF ELECTRICIANS.

BY

H. S. Carhart.

VARIOUS movements have been set on foot with the object of securing the attendance of foreign electricians of note at the International Congress of Electricians to be held in Chicago, in 1893. The American Institute of Electrical Engineers extended an invitation to the Paris Congress in 1889, and to the late Frankfort Congress, to be present in Chicago, a year from next summer; and the National Electric Light Association, at its recent meeting in Montreal, appointed a committee in the interest of the proposed International Congress of 1893.

The discussion of the subject in the electrical journals discloses the fact that much uncertainty exists relative to the auspices under which this Congress is to be held. Our report from the Frankfort Electrotechnical Congress says that the members in attendance were invited to Chicago, in 1893 to take part in a conference to be held under the auspices of the American Institute of Electrical Engineers. While such auspices would undoubtedly command respect abroad, they would not connect the undertaking officially with the World's Columbian Exposition, nor secure the recognition of the Government.

It is well known that the World's Congress Auxiliary is an organization authorized and supported by the Exposition corporation. It "has also been recognized and approved by the Government of the United States. Its general announcement has been sent to foreign governments by the Department of State, and an appropriation on account of its expenses has been made by act of Congress."

This organization will provide places of meeting and other appropriate facilities for various conventions or congresses to be held in Chicago at a convenient time in the Exposition season of 1893. It has already appointed a number of general committees to organize such congresses, to enlist the interest and co-operation of eminent men at home and abroad, and to secure if possible the attendance of the most distinguished representatives of each department of knowledge and activity at its respective congress or convention. These committees are necessarily resident in or near Chicago, but they are expected to procure the co-operation and aid of as many able men as possible, who will constitute an advisory council. The advisory councils are invited to aid the local committees by correspondence and by personal conference as opportunity may offer.

The chairmanship of the local committee on an electrical congress has been offered by the World's Congress Auxiliary to Professor Elisha Gray (who has signified his acceptance), and the vice-chairmanship to Col. Clowry. Mr. B. E. Sunny, the chairman of the Montreal Committee, is one of the committee of the Auxiliary; so also is the writer.

Since the movement for an International Congress of Electricians has now been inaugurated by the properly constituted authorities, and under auspices recognized by the World's Fair Directory and by the United States Government, it is intended that plans shall be rapidly matured, and that nothing practicable shall be left undone to secure co-operation both at home and aboad. The only electrical congress of great importance, thus far held, was the congress at Paris in 1881. Its decisions have been universally accepted, and its influence on the progress of the science of electricity has been plainly apparent ever since. If this supreme opportunity, presented by the World's Fair in 1893, can be rightly laid hold of, the gathering of electricians in congress at that time may prove no less fruitful in results than that at Paris ten years ago.

EARLY WORK IN INSULATION.

IN one of our English contemporaries, and more recently in one of our American, the desire has been expressed for information as to early work in insulating wires. As a matter of fact, such information is not far to seek, but since the matter is of general interest, it may not be amiss to recall the facts. The first recorded instance of the use of an electric conductor suspended in the air upon insulating supports was by Stephen Gray, a pensioner of the Charter-house London, who on July 2, 1729, transmitted an electric impulse through a pack-thread eighty feet in a horizontal direction, supported by threads of silk. In August, 1730, Gray transmitted a charge of elecritcity through 886 feet of wire supported in the same manner.

"C. M.," the unknown correspondent of the *Scot's Magazine*, who, in a letter dated at Renfrew, February 1, 1753, made the first definite proposal to employ electricity for the transmission of intelligence, appears also to have been the first to make the suggestion of enveloping the conductor in an insulating coating. Referring to the anticipated objection that the "electric fire" would become dissipated, or, as he quaintly phrases it, "entirely drained off in a few miles by the surrounding air," he says:

> "To prevent this objection and save longer argument, lay over the wires from one end to the other a thin coat of jeweler's cement. This may be done for a trifle of additional expense, and, as it is an electric *per se* [in modern parlance, an insulator] will effectually secure any part of the fire from mixing with the atmosphere."

Tiberius Cavallo's *Complete Treatise on Electricity, etc.*, published in London, 4th ed., 1795, pp 285-96, contains an account of certain experiments which the author says he "made some years ago" with the object of firing gunpowder and other explosives from a distance by electricity. His well-considered directions for insulating the conductors are minutely given as follows:

> "A piece of annealed copper or brass wire being stretched from one side of a room to the other, heat it by means of a flame of a candle, or a red-hot piece of iron, and as you proceed, rub a lump of pitch over the part just heated. When the wire has been thus covered, a slip of linen rag must be put round it, which can easily be made to adhere, and over this rag another coat of melted pitch must be laid with a brush. This second layer must be covered with a slip of woolen cloth, which must be fastened by means of a needle and thread. Lastly, the cloth must be covered with a thick coat of oil paint."

On the 29th of August, 1809, Dr. Samuel Thomas von Sömmerring read a paper before the Munich Academy of Sciences, descriptive of an electro-chemical telegraph which he had recently devised having 35 insulated wires.[1] Estimating the cost of such a telegraph; he says:

> "One line, consisting of thirty-five wires, laid in glass or earthen pipes, each wire insulated with silk, and measuring 32,827 Prussian feet, might be made for less than 2,000 florins."

In a letter dated July 30, 1810, written by Sömmerring to his friend Baron Larrey, in Paris, in reference to a model which he had sent thither from Munich for exhibition to the French Academy, he says:

> "The old conducting wires are somewhat damaged, and as it was entirely to avoid delay that I did not rearrange them before despatching the apparatus, I would be glad if they could be replaced by new wires, of the sort used in harpsichords, *covered with silk thread*, as the material of which these are composed is more durable than the old copper wires." * * * * "I am very much afraid that, besides the fragility of the copper wires, the rough usage to which they have been subjected in the course of experiment may have rubbed the silk off in places, and so may cause intermediate contacts of the metal, whence must result a derangement of the whole system."[2]

One of Sömmerring's original models is still preserved in the family of one of his descendants in Frankfort. It was exhibited at the Loan Exhibition at South Kensington in 1876, and may very probably be seen in the present Electrical Exhibition in Frankfort.

1. Über einen elektrischen Telegraphen. *Denkschr. Münch. Akad* 1811.
2. J. J. Fahie; *History of Electric Telegraphy, etc.*, p. 240.

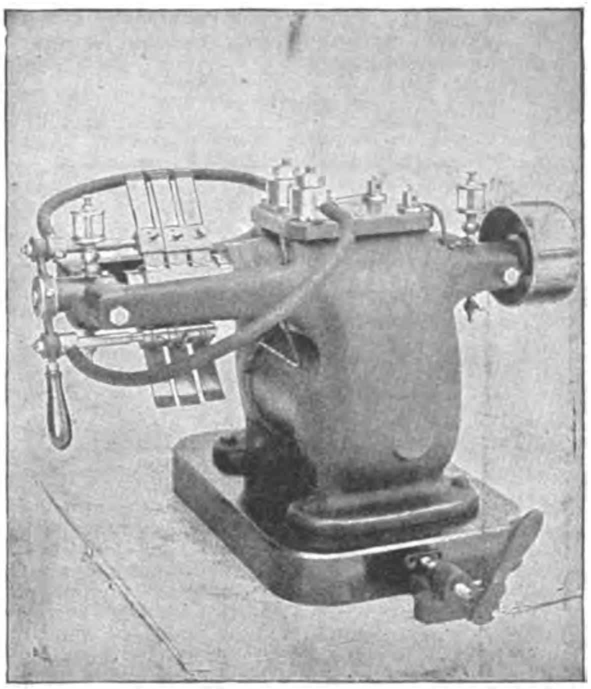
To Dr. Sömmerring, therefore, appears to be due the credit of being first to use conductors wrapped with silk; the first to employ a multiple cable of insulated conductors, and the first to use such an insulated wire for the transmission of voltaic currents.

It is not so generally known as it deserves to be that the first submarine wire insulated with gutta-percha ever laid in the world was constructed by Dr. John J. Craven, of Newark, N. J. With the assistance of his wife, he covered a piece of No. 16 copper wire by hand with gutta-percha. This insulated wire, which was about 15 feet in length, he experimentally submerged in the water of Bound Creek, a small tidal stream crossing the present line of the Pennsylvania Railroad midway between Newark and Elizabeth, N. J., and connected it in the circuit of the Morse line between New York and Philadelphia. This experiment, which was entirely successful, was made about the middle of September, 1847. Dr. Craven afterwards submerged a similar wire for the Magnetic Telegraph Company at the Passaic draw, near Newark, which was followed by the manufacture and laying of a cable a mile long across the Hudson River by the same company in the line of the Cortlandt street ferry. This was a No. 12 iron wire with three coats of gutta-percha. The first telegraphic communication sent through it was on the 15th of June, 1848.

The result of this undertaking led directly to the laying of a cable between England and France, which was successfully accomplished on the 27th of August, 1850.

COLBURN'S NEW DYNAMOS AND MOTORS.

Among the very first to go into the business of the practical manufacture of electric motors and dynamos, was Mr. I. W. Colburn, of Fitchburg, Mass., who has in the course of the past few years brought out many different designs and types of electric machines, all of which have found a successful field. Lately Mr. Colburn has organized his business into a company, now known as the Colburn Electric Manufacturing Company, and about the same time brought out a new design of motor, which probably excels all his previous designs in beauty, finish and efficiency. We illustrate in the accompanying engraving one his new machines, which are all more or less similar in design, but of varied purpose and capacity. The armature of this type of machine is built up of laminated Norway iron, insulated from the shaft by a wooden bushing, and having wooden blocks on the end, the whole being covered with asbestos and canvas before winding. The armatures are carefully balanced both before and after winding, and every bearing is carefully ground. The commutator, which is made of tempered copper, is on a solid steel shell, which is keyed to the shaft, and which is very easily removed, and is insulated by an asbestos bushing with laminated fibre at the ends. The bars of the commutator are insulated by sheet mica. All the bearings are self-oiling with an oil-well underneath, in which there is a revolving chain. The field-magnet is of wrought iron tapered at either end with a key slot, and fitting snugly into recesses in the cast-iron pole-pieces, which are secured to the field-magnet by one large bolt or stud. The carriers for the bearings are cast on the pole-pieces, and are bored out at the same time as the pole-pieces where the armature fits, thus securing a correct line. The bearings are turned and bored separately, and require only to be bolted in their places. This method of building the field-magnet and pole-pieces, secures a very short, intense magnetic field, has all the advantages of a wrought-iron core, and by means of the tapered ends, secures an excellent magnetic contact between the core and the pole-pieces. The bobbins of the field are made of tin insulated on the inside, and having leatheroid ends. All the bobbins are interchangeable, so that if a field should burn out at any time, all that has to be done is to take out the large bolt, the bolts of the bearings, draw back the pole-piece and slip on a new bobbin. The base of the machine is of wood, with a V-shaped groove and bar to slide on, and is supplied with a ratchet. The figure shows a 5 h. p. motor. The same types of machine are made for lighting, deposition, &c. The machines are all well finished and are well made throughout, and have given universal satisfaction wherever used. The dynamos are made in sizes of from four lights to 300, the motors from ¼ to 5 h. p., and the plating machines with a capacity of four to 400 ounces of silver per hour.



Colburn Five H. P. Motor.

THE MEASUREMENT OF LIQUID RESISTANCES.[1]

BY J. SWINBURNE.

The great difficulties in measuring liquid resistances arise from the polarization at the electrodes. Various methods of eliminating the errrors arising from polarization, and from variations of surface resistance due to bubbles, have come into use; the most usual being to employ an alternating current and a telephone. The following are some methods of avoiding polarization errors in a manner analogous to that employed by Sir William Thomson, Mr. Heaviside and others, in measuring low resistances. In measuring low resistances, the resistances of the contacts are high in comparison, and have to be eliminated. Fig. 1 shows the vessel employed. It consists of a glass tube, with cups, A and B, at the ends, for the main electrodes. Near the ends are feeler cups, C, D, and it is the difference of potential of these feeler cups that is measured. Tbey are connected by means of parchmented siphon tubes, such as those used in Raoult's cell, with vessels containing electrodes in a suitable electrolyte. For instance, suppose the resistance of sulphuric acid is to be measured. The main electrodes are platinum or lead. The siphon tubes are filled with acid, and connected to vessels filled with sulphate of zinc. The electrodes in these are zinc amalgam. The apparatus may be arranged either so that there is no current from C to D, or so that there is a current which may polarize the amalgams a little. In this case the polarization can be observed. Fig. 2 shows a method with no current. The main circuit from the battery E is

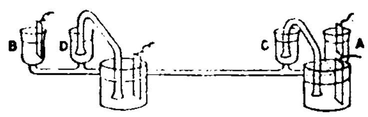


Fig. 1.

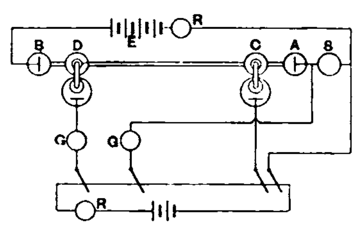


Fig. 2.

1. Abstract of a paper read before the British Association, in Section A, at Cardiff, August, 1891.

through a resistance, R, which is fairly large, so that variations of resistance or back pressure elsewhere in the circuit do not affect the current much. Then it passes through a standard resistance, S, to the main electrode, then through the tube back to the battery. The fall of pressure between the feelers C and D is compared with that over the standard resistance S by means of the potentiometer arrangement shown diagrammatically. For accurate work a resistance box is used; the wire is only shown for clearness. In this case there is no current in the feeler circuit, and, therefore, no polarization. A deflection can be taken on each side of zero, if desired, so as actually to reverse the current. Polarization of the feeler electrodes can also be detected instantly by breaking both the cell circuits. There should then be no deflection. The drawback to this method is that successive readings have to be taken, and if bubbles are coming off the main electrodes, the main current can never be quite constant. Fig. 3

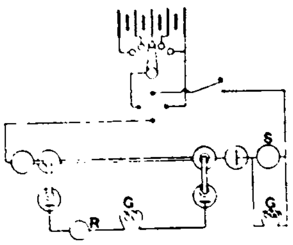


FIG. 3.

shows another disposition with a differential galvanometer, whose coils are lettered G G. In this case there is a current in the feeler circuit. To make sure that it produces no error the direction of the main current is commuted quickly at K. Any polarization then gives a double deflection. The apparatus may also be coupled up as a Thomson low-resistance bridge. By varying the number of cells, Ohm's law can be checked. As Prof. Stroud has pointed out to me, the resistances of the siphon tubes must be taken into account. They can, however, be made inappreciable in comparison with that of the galvanometer circuits.

Amalgamated zinc does polarize slightly, or some other action takes place which produces an equivalent result. Unless the time of contact is long, however, it does not give rise to trouble. Polarization shows at once by the deflection on lifting the main key.

The main tube is calibrated by filling it with mercury. Mine is straight, but it would be better to coil it up to go into a water bath easily. If one siphon tube is not enough, a second intermediate tube with a vessel can be used. I think one is generally enough, however. For instance, for measuring caustic sulphate of soda would be used in the siphon tubes, and so on. I have not experimented on various electrodes yet. Amalgams of silver or copper in suitable solutions, or mercury in mercurous nitrate, may be better than zinc amalgam in zinc sulphate.

THE TELEPHONING OF GREAT CITIES.[1]

BY A. R. BENNETT.

MR. BENNETT said that the establishment of an effective and popular telephone exchange in a large town, and one that can be added to and extended freely and economically, without pulling down what has already been done, involves the fulfillment of several indispensable conditions.

First—Speech must be loud and distinct, and privacy of communication complete. There must, furthermore, be an absence of all disturbing sounds.

Second—The arrangements must be so complete that eight or 10 seconds should be the maximum time occupied in calling and connecting within the compass of the largest town.

Third—The rates should not exceed $40 per annum.

Fourth—New subscribers in every direction and to any extent must be able to be added without interfering with the work already done.

What is necessary can be broadly indicated.

(1) The universal use of metallic circuits, and the absence from the line of intermediate electromagnets and other signaling devices.

(2) The provision of means by which certain and instantaneous communication can be secured.

(3) The division of the town into small sections, each worked from a switch-room placed at or near its centre.

It has always been a bugbear that telephonists have to fix their wires, not where they want them, but where they may.

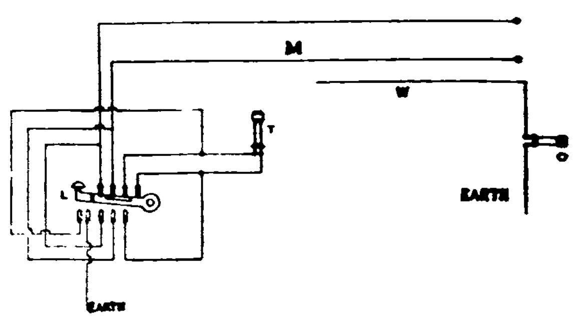
Without legislative assistance, which cannot consistently be withheld, efficient telephoning of great cities verges so near to the impossible that the author assumed that it will be forthcoming at the proper time. He said:

"All subscribers' lines will be metallic circuits. So long ago as 1883 I warned the National Telephone Company of the error they were committing in persisting in the use of the single-wire system. The opportunity was lost, and now cannot be regained without sacrificing the greater part of the capital they have expended. In Manchester my advice was taken, and universal commendation has resulted. The 'Mann' system enables connections to be obtained with certainty and celerity; it renders easy the task of getting rid of one connection and obtaining another. It simplifies and cheapens switching apparatus to an almost incredible degree, and it permits of connections being made through many switch-rooms without the intervention of intermediate electromagnets, so that no retardation and indistinctness of speech result.

"The main feature of the system is the service wire. One such wire is allotted to every 60 to 100 subscribers, according to the amount of traffic passing. During the busy hours of the day operators are always listening on the service wires, so that subscribers may speak and be heard without any premonitory signals. The subscriber, on his part, can at any moment place himself in communication with the operator by depressing a small lever, which has the effect of changing his instrument temporarily from his main line to the service wire."

It occured to Mr. Bennett that, on the "Mann" system, it might be possible to convey the service messages between subscribers and operators by means of electrostatic induction between the subscriber's metallic loop and a special single wire run out for a sufficient distance from the exchange amongst each group of metallic circuits.

On arranging the wires and apparatus in the manner indicated in the accompanying diagram it was found that such a plan was really practicable. Here M is the subscriber's metallic circuit, forming, when the lever is depressed, the subscriber's side of the condenser; L is the subscriber's lever changing his phone T from metallic circuit to earth; W is the insulated wire forming operator's side of the condenser, and O is the operator's phone. The connections of the subscriber's instrument were altered in such a way that, on depressing the lever, the metallic circuit M was put to earth through the telephone. The metallic circuit then acted as a single wire of double area, and, whether insulated at the switchboard or connected through to another circuit, practically formed one plate of a condenser, the other plate or plates of which were any of the adjacent wires that happened to be earthed at their extremities.



TELEPHONING BY ELECTROSTATIC INDUCTION.

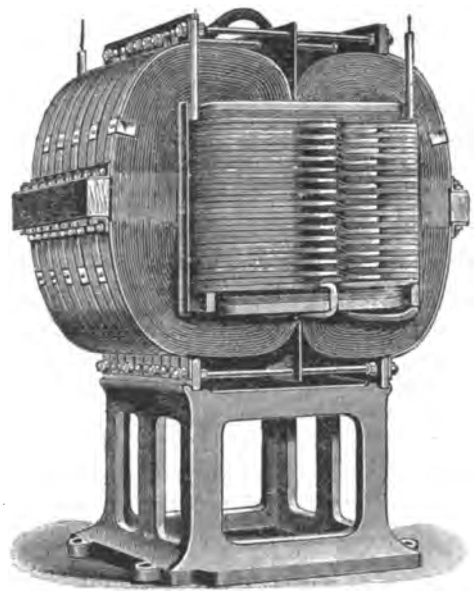
It was, therefore, only necessary to put the operator's instrument in permanent connection with one or more wires running parallel to the subscriber's metallic circuit for a short distance, to enable any of the subscribers, whose instruments were so fitted, to communicate with the operator by depressing their levers. When the levers were not depressed, the telephones were looped in the metallic circuits as usual, and the operators could neither hear or be heard. When cables were used containing 36 or even 72 metallic circuits, it was only necessary to connect the operator's instrument to a single wire placed in the centre of the cable, or to the metallic sheathing of the cable, to obtain perfectly good speaking when the metallic loops were earthed by the subscribers depressing their levers. When a connection has to be obtained through more than one switch-room, it is asked for by each operator in succession by depressing a lever which puts the required operator in communication with the service wire to which the operator at the next switch-room is giving attention.

The Mann system is specially applicable to large cities, and Mr. Bennett, therefore, proposes to supply a town like London, which ought to have tens of thousands of subscribers, by arranging numerous small local exchanges on the Mann system. The small exchanges would call through to one another. In this way a city of any size may be easily, efficiently, and economically served.

1. Abstract of a paper read before the British Association at Cardiff.

THE FERRANTI SUB-STATION TRANSFORMER.[1]

THE accompanying figure shows one of the Ferranti 150 h. p. transformers, specially designed as a sub-station instrument for reducing pressure from 10,000 or 5,000 to 2,400 or 2,000 volts. The transformer consists of three coils—viz., of one high-pressure coil, which is sandwiched in between two low-pressure coils. Each of these coils is composed of a copper strip separated by a strip of vulcanized fibre and wound over with shellaced cloth and vulcanized fibre. In forming these coils a number of separate



FERRANTI TRANSFORMER.

flat coils are built up one over the other, and connected together in series, insulating material being placed between every elementary coil. The high-pressure and low-pressure coils are separated from one another by sheets of ebonite, with a considerable air-space between. The iron cores are exceedingly massive, and formed of flat bands bent over in opposite directions to form closed magnetic circuits; the various layers of iron bands are separated from one another by an air-space of a half inch, to provide for ventilation, or, in cases where the transformer is placed in oil, to allow a free circulation to the oil. It is advantageous to immerse these high-tension transformers under the surface of an insulating fluid, diminishing thereby the liability to electrical discharge between the high-pressure coil and the iron frame, or the low-pressure coil, which exists by virtue of the powerful electrostatic field in the neighborhood of the high potential end of the high-pressure coil.

THE LIGHTING OF THE EMPIRE THEATRE, PHILADELPHIA.

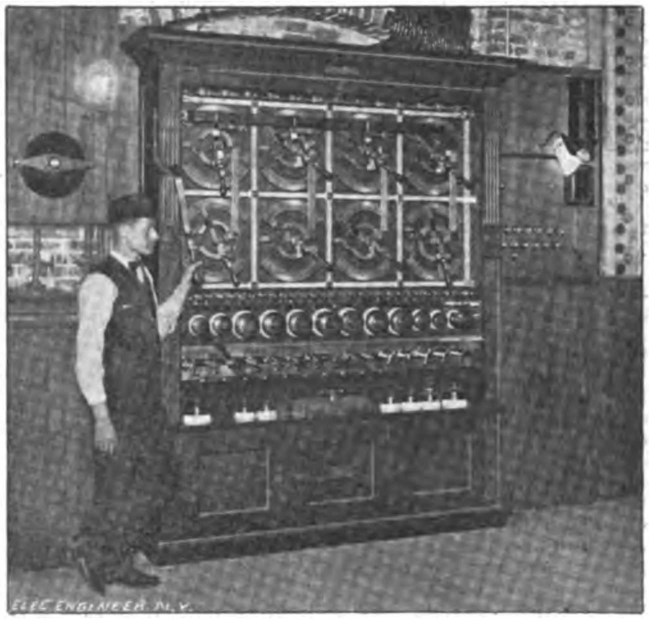
THE new Empire Theatre, opened in Philadelphia on August 29th, is the most beautiful of all the Philadelphia playhouses, and has attracted a great deal of attention both on account of its picturesque and well-lighted interior, and its original and striking exterior. Mr. Angus S. Wade, the architect, has designed a structure theatrical in appearance from foundation to roof, and, in departing from many old-established forms, has created a place of amusement which is a model of excellence and convenience. The theatre is lighted by electricity by a plant of its own, the electrical work all being done under the personal supervision of Dr. W. A. Drysdale, consulting electrical engineer, and, it is said, excels anything of the kind heretofore attempted.

The façade of the theatre is of light buff brick, trimmed with Indiana limestone. Turrets flank either side of the main entrance, entirely detached from the auditorium, containing the stairways from the lobby to the balcony, and between them in the second and third stories extend open balconies with balustrades and arches of copper, designed after the Moorish. On the keystone of each of these arches is hung a large incandescent lamp covered by an antique twisted globe. These lamps, hung under the eaves of the balconies, and partially concealed from the street, casting a glow over the dull copper work, and, outlining the building with its Moorish forms, produce a truly beautiful effect, making the façade look like the entrance to a Moorish castle, and giving the building a general effect from the street which surpasses anything hitherto attempted in outside lighting; an effect in which the arc lamp plays no part, and which would be destroyed by its use.

There is an absence of fixtures in the lobby, the lights being in crystal globes between the projecting rafter ends of papier-maché, beneath the roofs of the vestibule and box-office. In the broad stairways leading from the lobby to the balcony are side brackets of brass, bearing lamps, and one noticeable feature in the lighting is that no shadows are cast on the stairways.

The lighting of the auditorium is a radical departure from anything that has hitherto been attempted in theatre illumination. Fixtures of Moorish design, forming capitals for the columns supporting the balcony and gallery, contain the lamps which are usually placed on the face of the balcony and gallery themselves, and this arrangement gives the audience in these parts of the house an unobstructed view of the stage. The box lighting is so arranged that the lamps are out of sight of the audience. A novel effect of lighting is in the box canopies, the roofs of the boxes forming great lanterns of stained glass, giving a soft light, that harmonizes with the draperies of the boxes below.

Looking toward the stage, the attention is arrested by the lowness of the footlight apron, it being only a few inches above the stage floor, although the lights are entirely concealed from the audience. The footlights are 150 in number, fifty each of green, red and white. The border lights are so hung that all the light is cast upon the stage, and not lost in the rigging loft, as is too often the case. Ground rows or additional footlights, beside the customary bunch lights, assist in furnishing a perfect illumination for the stage.



SWITCHBOARD, EMPIRE THEATRE, PHILADELPHIA.

Every provision has been made on the stage for spectacular and striking effects. Special arc lamps are used throughout the house instead of the time-honored calcium light. The switchboard, constructed by John P. Cushing & Co., of Boston, is an excellent piece of work in all its details. It is made of quartered oak 6 feet 6 inches high by 8 feet 3 inches wide, and stands on a cabinet 17 inches high by 8 feet 6 inches wide, containing the cut-outs and bus bars. The whole board is protected by a roll-top cover. The board, which is shown in the accompanying engraving, controls 200 lights for the borders, 150 footlights, 240 bunch-lights, and 1,000 lights for the house, which are controlled by 34 different circuits, these circuits being again subdivided after leaving the board. Ten circuits are on gang snap switches, which can be worked one at a time, or all together, by means of a lever. The whole is controlled by one break-down, reciprocally-acting switch.

The greatest care has been taken with the wiring of the building, interior conduit being used throughout. A distinctive feature of the arrangement of the circuits is that no cut-outs are located in the auditorium, these all being placed on the stage, so that a blowing fuse can in no way alarm the audience, and can be replaced at once without confusion. The auditorium lighting is divided into two circuits controlled by separate rheostats. This arrangement has been provided to permit of the darkening of the body of the house, leaving the sidewalls lighted to permit the convenient ingress of the audience in case of there being a dark scene in the early part of the play.

The plant for the lighting of the theatre and Hotel Metropole,

1. London *Electrician*.

adjoining, is in a separate building, and consists of one 150 h. p. Gill tubular boiler, 100 h. p. Woodbury engine, and two 240 ampere Edison dynamos. The entire plant when completed will consist of four 240 ampere dynamos, two 100 h. p. Woodbury engines, and 450 h. p. of boilers, the switchboard being so arranged that either engine can take charge of either the lighting of the theatre or Hotel Metropole, or the buildings can be lighted by the current from the street in case of the remote possibility of a break-down of the plant. Only enough gas is used in the theatre to dismiss the audience in case of accident, no gas being used on the stage. The Hotel Metropole will be erected in the spring on the site next to the theatre, and the lighting of this building will also be under the supervision of Dr. Drysdale.

In the theatre every device and precaution known to the art has been used to make the installation absolutely safe and free from danger of fire, and through the liberality of Mr. John M. Sharp, the owner, no expense has been spared to make the entire theatre and plant perfect in every detail. The contractors for the electrical equipment were Messrs. Walker & Kepler, who have very successfully carried out the specifications of the consulting engineer.

SOME FIGURES OF THE MINNEAPOLIS ELECTRIC RAILWAY.

THE July report of the street railway systems of Minneapolis and St. Paul is the first of the monthly returns in which no horse account appears, and as such, is of especial interest to the advocates of the electrical car and the overhead system of propulsion. It appears from the report that the gross earnings for the month were $107,571, the expenses $52,585 and the net earnings $54,985. More than ordinary interest has been taken generally in the success of the St. Paul and Minneapolis system because it represented the largest electric system in the world, and furnished a perfect test of the overhead trolley as furnished by the Thomson-Houston Co. With a view to getting at the facts respecting the satisfaction with which the system in vogue is regarded by the management, Mr. Thomas Lowry, who is at the head of the business, was interviewed while on a brief visit in Boston recently, and expressed himself as perfectly satisfied with its operation.

"We hear nothing but praise," said Mr. Lowry. "Here are to-day nearly 350,000 people and not a horse car in either city. Minneapolis has 120 miles of street railway all equipped with the overhead electric system, with posts set in the middle of the street and arms for the wires extending over the track on either side. St. Paul has 90 miles of street railway; 75 miles of it are in the electric system and 15 miles in cable, but we shall take up part of the cable road and supplant it by electricity, except where we have to mount a 17 per cent. grade. Here we must keep the cable in. One can now travel by our electric line from the north side of Minneapolis to St. Paul parks, over 20 miles, upon a transfer check.

"The expenses for operating during July," continued Mr. Lowry, "were less than 49 per cent., and I feel perfectly sure that within two years we shall be operating our entire electric system of 215 miles in two cities for less than 40 per cent. for expenses. A year ago our Minneapolis lines were earning about $70,000 a month. We have increased our gross earnings 50 per cent. by the improved facilities which the electric lines afford to the traveling public. All the people in the Northwest are enthusiastically in favor of the electric system. We have had every kind of power, and find in the winter the overhead electric is better to work through snow drifts than either steam, horse or cables, and we have tried them all. We have used electricity now for two years, and we think we know something about motor repairs and the general repair account, and we expect this account to diminish instead of increase. The principal item is the burning out of the armatures, but this becomes less as the employees become more experienced, and operations become systematized."

Lima oil is used principally for fuel. This is brought from Ohio and costs, landed there, $1 per barrel. Experts figure that it takes three barrels to make the equivalent of a ton of coal, and Mr. Lowry estimates that it costs only $1 for power a day to run an electric car where 150 cars are being operated in the system as at present. Horses used to cost the company $3.85 to $4 a day per car, with the low-priced grain. The cars now make a greater number of trips per day, and transport a correspondingly larger number of passengers.

During the interview Mr. Lowry made some interesting comparisons between his own lines and those of other cities operated similarly by the overhead system. Among these was the West End Street Railway Co., of Boston. As an expert his opinion regarding its possibilities is worthy of consideration. He had just been looking over the June monthly statement of the West End Co. and stated, as his opinion, that, with the volume of traffic which it had to deal with, it will operate with a good deal less than 50 per cent. for expenses when the horse cars shall have been dispensed with. He thought that with these out of the way, nearly a third more trips could be made with the same equipment. He believed that Boston expenses for the electric system, with its immense traffic, could be gotten down to 35 or 40 per cent., and he predicted that with the great volume of street traffic there, West End will operate for 40 per cent. of its gross receipts when its electric system is completed, for as the traffic grows, the ratio of expense diminishes.

"The ratio of operating expenses on the electric system," Mr. Lowry concluded, "is downward, not upward. My report for July covers 11 electric lines for the month. The line of our heaviest traffic, 9½ miles between Minneapolis and St. Paul, shows only 35 per cent. of a 5-cent fare as cost of operating. We run trains of two cars on this line, and we are going to run three cars as the traffic increases. The principal increase in expense will be the cost of a conductor, as we have a man on each car. Two years ago when we started to introduce electricity, the street railway gross earnings in St. Paul and Minneapolis were only about $800,000. We are now earning, and shall earn this calendar year, $2,000,000 gross. Next year we expect $2,500,000, and 1893 should give us $3,000,000 of gross earnings, or half what the West End earns."

Rochester, N. Y., was cited as a place where an overhead system of 60 miles is being operated for 44 per cent. of its gross receipts.

ELECTRICAL UNITS AT THE BRITISH ASSOCIATION.

OUR London correspondent, under a recent date, writes us as follows in regard to the late interesting discussion at the British Association meeting, on electrical units.

The joint discussion with the Mechanical Science Section on "Units and Their Nomenclature" was opened by Professor Oliver Lodge. He said it would probably be best to divide the subject into two parts, taking the electrical units first, as far as possible, and leaving the discussion on mechanical units, which was of a less practical, and more academical, character, to a later stage. One practical unit which had not yet received an officially recognized name, and which is, nevertheless, very largely used, is that of self-induction. Two names have been proposed for it, secohm and quadrant. The first of these is open to the objection that it regards the unit of self-induction as one derived from the ohm, whereas in reality the former is the more fundamental unit, and in ascertaining the value of the ohm the determination of self-induction is necessary. Again, the term quadrant was objectionable, because it led to the idea that the unit of self induction was a length, thus ignoring the dimensions of magnetic permeability. There is moreover, some question as to whether the present unit of self-induction is not too large, and it might be advisable to attach a name to a unit whose value is one hundreth or one-thousandth of the secohm. Again, the present unit of magnetic field is too small, and was introduced from reference to magnetic poles, whereas now it is used almost exclusively in connection with induced currents. Professor Lodge showed also that it would be convenient to have a unit in terms of which the whole number of lines of force passing through any circuit can be measured.

Mr. W. H. Preece thought the idea of naming the unit after deceased physicists a very good one, and he hoped, therefore, that the unit of self-induction should be connected with the name of Henry. Although advocating a strict conservatism with regard to the present absolute system of units, he desired to suggest that the unit of electromotive force be increased tenfold, seeing that the present value of the volt is rather too small for practical use, and was originally chosen simply because it happens to be nearly equal to the electromotive force of a Daniell cell. Moreover, the proposed change would get rid of the existing discrepancy between the ampere and coulomb and the corresponding absolute units. Mr. Preece also suggested that physicists should devote themselves to a closer determination of the absolute dimensions of specific inductive capacity and magnetic permeability.

Professor W. Stroud read a paper, as a contribution to the discussion, in which he advocated the adoption of an earth quadrant as the unit of length for the practical system, and the one thousand millionth of a gramme as the unit of mass, the unit of time being one second, as at present. This would lead really to Mr. Preece's suggestion. The unit of power would be a hundred times greater than at present, and would be, therefore, about one-seventh horse power. He deprecated any interference with a clear distinction which is at present preserved between the practical and the absolute systems of electric units, but thought a unit of force or value equal to a million, or even a thousand million, dynes would be useful in connection with both systems.

Mr. J. Swinburne thought a unit of self-induction was not used in practice as often as was supposed, and he hardly thought it necessary to give a name to it.

Dr. D. J. Stoney said that in 1874, while sitting on the committee which fixed the present units, he objected to making the dyne and erg so small at that time. Siemens objected also to using the centimetre as the unit of length, but no system could be devised in which some of the units were not awkwardly large or small. It was then suggested to use multiples and sub-multiples of the fundamental units, each physicist selecting those which would be most useful for his work. The notation suggested was to use powers of 10. Dr. Stoney also hoped that some method could be found of getting rid of the word "force" in terms such as "electromotive force." He suggested, to this end, that this should be called energy, the factors being energy per unit quantity. The corresponding forces would be force-factors or potencies, and would be spaced variations of the energy-factors.

Professor Carey Foster hoped that if any new unit of electromotive force were agreed upon, it would be provided with a new name. It would be exceedingly awkward if any one referred to a volt not to know whether the old or the new value was meant.

Professor Rucker insisted upon the recognition of the factor's specific inductive capacity and magnetic permeability in dimensional equations, and objected to our assuming any absolute dimensions for electrical constants.

Professor S. P. Thompson thought that in a certain way analogous to that used by Sir Wm. Thomson in the case of electrical resistance, the self-induction of a wire or coil might be represented by a length. He also thought some clue to the dimensions of permeability and inductive capacity might be obtained by ascertaining what dimensions of them would clear all the equations of fractional indices. He also asked for the recognition of vector quantities in dimensional equations, and showed how it might be secured.

Mr. T. H. Blakesley wanted a new unit representing the square of a current. The angular deflection of a dynamometer would directly measure such units.

Professor Lodge, in reply, called upon the members to take every opportunity of abusing the present electrostatic and electromagnetic systems of units, but to retain them until our increased knowledge enabled us to bring forward a better and more scientific system. He hoped that the discussion would be continued in the scientific papers during the year, and that something definite might result.

At last we have a report of the committee who were appointed on the question of electrical measurement. You may remember that at the end of last year a committee was appointed by the Board of Trade to consider and report whether any, and if so, what, action should be taken by the board under the Weights and Measures Act, 1889, with a view of causing new denominations of standards for the measurement of electricity for use for trade to be made and verified. The committee to which Sir T. Blomefield acted as secretary consisted of Mr. Courtney Boyle and Major Cardew, representing the Board of Trade; Mr. Graves and Mr. Preece, the Post Office; Sir W. Thomson and Lord Rayleigh, the Royal Society; Professor Carey Foster and Mr. Glazebrook, the British Association; and Dr. Hopkinson and Professor Ayrton, the Institution of Electrical Engineers.

The report published recently, to which are appended the specifications referred to in resolution 10 and the draft order to Council, is as follows:

In compliance with the instructions contained in your minute of the 16th December last, that we should consider and report whether any, and if so, what, action should be taken by the Board of Trade under Section 6 of the Weights and Measures Act, 1889, with a view to causing new denominations of standards for the measurement of electricity for use for trade to be made and duly verified, we have the honor to submit the following report:

1. Before coming to a decision as to the points referred to us, we were anxious to obtain evidence as to the wishes and views of those practically interested in the question, as well as local authorities, who are concerned in the administration of the Weights and Measures Act.
2. With this view we prepared draft resolutions embodying the proposals which, subject to further consideration, appeared to us desirable, and forwarded copies to the representatives of various interests for criticism. Copies were also forwarded to the press. The following bodies were also invited to nominate witnesses to give evidence before us; The Association of Chamber of Commerce of the United Kingdom, the Association of Municipal Corporations, the London County Council, and the London Chamber of Commerce.
3. In response to this invitation the following gentlemen attended and gave evidence: On behalf of the Association of Chambers of Commerce, Mr. Thomas Parker and Mr. Hugh Erat Harrison; Professor Silvanus Thompson, on behalf of the London County Council; Mr. R. E. Crompton, on behalf of the London Chamber of Commerce.

The committee state that they were assisted by Dr. J. A. Fleming and Dr. Alexander Muirhead. After careful consideration of the questions submitted to us and the evidence given by the various witnesses, we have agreed to the following resolutions:

1. That it is desirable that new denominations of standards for the measurement of electricity should be made and approved by Her Majesty in Council as Board of Trade standards.
2. That the magnitudes of these standards should be determined on the electromagnetic system of measurement with reference to the centimetre as unit of length, the gramme as unit of mass, and the second as unit of time, and that by the terms centimetre of gramme are meant the standards of those denominations deposited with the Board of Trade.
3. That the standard of electrical resistance should be denominated the ohm and should have the value of 1,000,000,000, in terms of the centimetre and second.
4. That the resistance offered to an unvarying electric current by a column of mercury of a constant cross-section, of an area of one square millimetre, and of a length of 106.3 centimetres, at the temperature of melting ice, may be adopted as one ohm.
5. That the value of the standard of resistance constructed by a committee of the British Association for the Advancement of Science, in the years 1863 and 1864, and known as the British Association unit, may be taken as point .9866 of the ohm.
6. That a material standard, constructed in solid metal, and verified by comparison with the British Association unit, should be adopted as the standard ohm.
7. That for the purpose of replacing the standard if lost, destroyed or damaged, and for ordinary use, a limited number of copies should be constructed, which should be periodically compared with the standard ohm and with the British Association unit.
8. That resistances constructed in solid metal should be adopted as Board of Trade standards for multiples and sub-multiples of the ohm.
9. That the standard of electrical current should be denominated the ampere, and should have the value of one-tenth, in terms of the centimetre, gramme, and second.
10. That an unvarying current which, when passed through a solution of nitrate of silver in water, in accordance with specification attached to this report, deposits silver at the rate 0.001118 of a gramme per second, may be taken as a current of one ampere.
11. That alternating current of one ampere shall mean a current such that the square root of the time average of the square of its strength at each instant in amperes, is unity.
12. That instruments constructed on the principle of the balance in which by the proper disposition of the conductors, forces of attraction and repulsion are produced, which depend upon the amount of current passing, and are balanced by known weights, should be adopted as the Board of Trade standards for the measurement of current, whether unvarying or alternating.
13. That the standard of electrical pressure should be denominated the volt, being the pressure which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere.
14. That the electrical pressure at a temperature of 62° F., between the poles or electrodes of the voltaic cell known as Clark's cell, may be taken as not differing from a pressure of 1.433 volts by more than an amount which will be determined by a sub-committee appointed to investigate the question, who will prepare a specification for the construction and use of the cell.
15. That an alternating pressure of one volt shall mean a pressure such that the square root of the time average of the square of its value at each instant in volts is unity.
16. That instruments constructed on the principle of Sir W. Thomson's quadrant electrometer used idiostatically, and for high-pressure instruments on the principle of the balance, electrostatic forces being balanced against a known weight, should be adopted as Board of Trade standards for the measurement of pressure, whether unvarying or alternating.

The committee further state that they have adopted the system of electrical units originally defined by the British Association for the Advancement of Science; and have found in its recent researches, as well as in the deliberations of the International Congress on electrical units, held in Paris, valuable guidance for determining the exact magnitudes of the several units of electrical measurement, as well as for the verification of the material standards.

It appears to the committee to be necessary that in transactions between buyer and seller a legal character should henceforth be assigned to the units of electrical measurements now suggested, and with this view recommend the issue of an Order in Council.

THE PHOTOCHRONOGRAPH.

REV. GEO. A. FARGIS, S. J., of the Georgetown College Observatory. Georgetown, D. C., has recently invented an instrument called the photochronograph, by means of which a star is caused to record with absolute accuracy the time of its own transit across the meridian, thus eliminating all personal errors. The apparatus is thus described: In a small camera, attached to the eye-piece of the transit instrument, a highly sensitive plate is inserted. Electric connection is made with a sidereal clock in such a manner that a narrow shutter or bar is moved up and down before the plate, cutting off and admitting the light of the star at stated intervals during its passage across the field. The image of the spider line is afterward impressed upon the plate by the light of a lamp held for a few moments before the object glass of the telescope. By means of the shutter or bar this light is prevented from interfering with the star trail on the plate, which may be subjected at any time to repeated examinations and measurements with a microscope.

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

ABSOLUTE UNIT OF MAGNETIC INTENSITY.

IN your issue of Oct. 7th there is a mistake which should be corrected. In Mr. Gutmann's article on the Frankfort Electrical Congress, page 398, first column, bottom of page, I am reported as having proposed the name "weber" for the "absolute unit of magnetic intensity." This was *not* what I proposed, nor was it the way my proposition was understood by the committee to whom it was referred.

In what might be termed "canvassing" for the adoption of the name "gauss," as proposed by the delegates of the American Institute of Electrical Engineers, I found in my conversation with a number of prominent electricians that there would be considerable opposition, because some wanted this name given to the practical unit for the *number* of magnetic lines of force as distinguished from the *intensity* (i. e., number of lines per square centimetre also called "density of lines"), as proposed by the American delegates. In order to meet this objection, and thereby to accomplish our object by obtaining unanimity of opinion among some of the prominent members of the Congress, I proposed as an amendment that *both* of these magnetic units be named, and that the former be named "weber." The name "weber" would then be the name of the practical unit of the *whole number of magnetic lines*, also called *magnetic flux*, and often represented by the letter **N**; while the name "gauss" would be, as originally proposed, the name of the practical unit of magnetic *intensity* or *density of lines*, or *number of lines per square centimetre*, and often represented by the letters **B** or **H**.

This had the desired effect, and the proposition in this form appeared to meet with general favor. The disagreement was as to the *numerical values* to be given these units and their *relative values*.

I trust you will publish this in your next number, as Mr. Gutmann's article unintentionally represents me as having proposed "an absolute unit of magnetic intensity" on the one hand, and on the other hand the name "weber" for the same thing for which we had proposed the name "gauss." I was not guilty of having done either of these, nor was my proposition so understood by the committee of which I was secretary, and therefore have reason to know.

CARL HERING.

PHILADELPHIA, PA., Oct. 7.

ECONOMY IN ELECTRIC POWER DISTRIBUTION.

I HAVE read the article in your issue of Oct. 7th, entitled, "Economy in Electric Power Distribution," by J. Stanford Brown, in which he endeavors to show that in my paper on this subject I made an error by neglecting to take consideration of the efficiency of the motor.

All of my formulæ refer to electric energy in kilowatts at the end of the conductor, that is, at the brushes of the motor, while Mr. Sprague's formula is for mechanical power at the pulley of the motor, making it necessary, in his case, to take into consideration the motor efficiency.

I judge from Mr. Brown's article that he thinks my formulæ refer to horse-power at the pulley, as he says: "Mr. Leonard, desiring to figure in kilowatts, reduces his horse-power thereto by dividing by 1,000 and then introduces the factor 1,000 in his constant to get them back again to horse-power."

I beg to correct this impression by calling attention to the fact that in no part of my paper did I consider horse-power, hence I did not "reduce" from any such unit to kilowatts, nor did I get my kilowatts "back again to horse-power."

Since my formulæ refer to kilowatts at the end of the conductor, it is evident that the motor efficiency is not a factor. My formulæ were intentionally put in such shape as to apply whether the energy be used for motors, incandescent lamps, storage batteries, electric heaters, electro-deposition, or any other use.

H. WARD LEONARD.

NEW YORK, Oct. 7, 1891.

Reports of Companies.

THE WESTINGHOUSE ELECTRIC AND MFG. CO.

SUBSCRIPTIONS for $3,000,000 7 per cent. cumulative preferred stock of the Westinghouse Electric and Mfg. Co. will be received at par by August Belmont & Co., New York, and Lee, Higginson & Co., Boston. The company's authorized capital is $10,000,000, of which $4,000,000 is preferred. The balance, $1,000,000, of the preferred stock above the amount offered for subscription will remain in the treasury to meet future requirements of the business. The statement of the company, embodied in the prospectus on another page, presents a notable growth of business, which is again likely to be increased by the general introduction of electric lighting and electric power. The factories now have a capacity of caring for an annual business of over $7,500,000. An official examination of the assets shows that after making liberal deductions for contingencies, the assets will furnish ample security for the total issue of preference stock without taking into consideration the value of the company's patents, and that the working capital will be sufficient to conduct the business on an economical basis, the saving in the interest account alone being sufficient to pay full dividends on this issue. The subscription books will be opened at 10 a. m. on Wednesday, Oct. 14, and close at 3 p. m. Oct. 16.

STANLEY & HALL.

THOMAS F. STEVENSON has been appointed receiver for Stanley & Hall, manufacturers of electrical supplies, at 34 Frankfort street, New York City. The business was started about ten years ago by E. W. Hazazer, who was joined by Arthur F. Stanley in October, 1886, and Harry Hall became a partner in March, 1890. The business was turned into a stock company in April, 1890, with a capital stock of $20,000, which was afterwards increased to $30,000, the new stock being taken, it is said, by Sheldon H. Bassett, of Birmingham, Conn., who became vice-president. Royal M. Bassett, the latter's father, it is said, loaned the company money, which was secured by a chattel mortgage for $10,000 in August last. The receivership, it is said, is in the interest of Mr. Bassett. The company, it is reported, has about $12,000 unsecured debts, and there is due it about $14,000 from customers, besides some stock and plant on hand. The firm has many friends, and is expected soon to be in shape again to do a large trade.

THE WILLSON ALUMINUM CO.

THE Willson Aluminum Co. has been organized with a capital stock of $45,000 to manufacture aluminum under the patents of Thos. L. Willson, of Brooklyn, N. Y. The works will be at Spray, Rockingham county, N. C., and will have a capacity of 400 pounds per day. The company has had built a dynamo of 1,000 h. p. A large water-power is at the command of the company. The works will be in operation in the early part of next year. The aluminum will, it is said, be produced from corundum and bauxite.

DIVIDENDS.

NEW YORK CITY.—The Edison Electric Illuminating Co., of New York, has declared its twenty-sixth quarterly dividend of 1 per cent.

WASHINGTON, PA.—The Washington Electric Light & Power Co. has declared a dividend of 3 per cent. It is doing an increasing business.

NEW BEDFORD, MASS.—The New Bedford Gas and Electric Light Co. has declared a dividend of 1½ per cent.

Appointments, Etc.

MR. A. H. HYDE has joined the forces of the Minnesota Brush Electric Light Co., of Minneapolis, with charge of its underground work lately installed by the Standard Underground Cable Co.

MR. FRANK DRULINER, who has for some time been connected with the South Bend Electric Co., has resigned his position, and will enter upon studies at Cornell, taking the electrical engineering course.

MR. H. A. SAWYER, late superintendent of the electric light company at Amesbury, Mass., has gone into the electrical supply and wiring business in that town.

MR. F. N. PRUYN has assumed the management of the Thomson-Houston Light, Heat and Power Co., of Binghamton, N. Y., taking the place of Mr. C. J. Morehouse.

MR. C. E. HUGHES has been elected superintendent of the fire alarm system of St. Paul, Minn. He was formerly manager of the Western Union office.

MR. E. H. WALDO, of Lynn, has been appointed superintendent and electrician of the Milford, Mass., Electric Light and Power Co.

MR. A. MARTIN, late of the Lynn Belt Line Electric Railway, has taken charge of the Gloucester, Mass., Electric Street Railway.

MR. H. M. UNDERWOOD has severed his connection with the Interior Conduit & Insulation Co., of this city.

MR. G. B. COLEMAN has resigned his position as superintendent of the Milford Electric Light and Power Co.

DR. P. E. MURRAY has been appointed manager of the Western Union office at Atlanta, Ga.

Legal Notes.

ELECTRICITY NOT A MANUFACTURED ARTICLE.

JUDGE SIMONTON'S decision in the case of the Commonwealth against the Northern Electric Light and Power Company having been affirmed by the Supreme Court of Pennsylvania, the question as to whether electricity is a manufactured article is pretty definitely settled in the negative. This was a test case, and was the result of a combination of electric light companies to determine their liability to taxation.

They claimed to be exempt under the act exempting manufacturing corporations. The State will receive a large amount in taxes as the result of this decision.

THE GOVERNMENT TELEPHONE SUIT.

THE suit of the United States of America against the Bell Telephone Company and Alexander Graham Bell to try the question as to whether the patents of the latter were obtained from the Patent Office at Washinton by fraud is now before Mr. Henry L. Hallett, who is taking testimony.

College Notes.

RENSSELAER POLYTECHNIC INSTITUTE.

MR. C. C. MARTIN, of the Brooklyn Bridge Company, has, it is understood, declined the offered directorship of the Rensselaer Polytechnic Institute. It is said that the Bridge Company have increased his salary considerably, which, if true, would account for his declining the honor of the office tendered him by this celebrated school.

Society and Club Notes.

BUFFALO ELECTRICAL SOCIETY.

THE annual meeting of the Buffalo Electrical Society was held on Oct. 5th. In the President's report he took occasion to congratulate the members on the prosperous condition of the society's affairs, and on the success which had attended their efforts during the past year. The secretary's report showed an increase of 25 per cent. in membership, and the treasurer's report, a respectable balance on hand. The society now has one of the best electrical libraries in the country. The following officers were elected: President, F. P. Jones; vice-president, Madison Buell; secretary, Astley C. Terry; treasurer, Samuel Stewart; librarian, Wm. C. Lewin; executive committee, Frank Kitton, Wm. H. Dopp, M. Beecher Marvin and the elected officers.

BROOKLYN INSTITUTE.

MR. F. B. HENSHAW, electrical engineer of the C. & C. Motor Co., is to read an illustrated paper before the electrical section of the Institute, Friday, Oct. 16, at the Y. M. C. A. Building. His subject is "The Designing of Electric Motors."

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

OWING to the fact that many members of the Institute will be in attendance at the Pitsburgh Street Railway Convention, the regular monthly meeting will be postponed until Oct. 27.

Obituary.

C. R. DINSMORE.

MR. C. R. DINSMORE, superintendent of the Marblehead Gas and Electric Co., died on Oct. 4, at Marblehead, aged 29 years. He had resigned his position as superintendent of the gas works, to take effect Oct. 15.

NEW YORK SUBWAYS.

AT the meeting of the New York Board of Electrical Control, last week, permission was given for the building of subsidiary subways through 45 streets in various parts of the city. There was a protracted contention between ex-Judge W. H. Kelly for the East River Company and Edward Lauterbach for the Consolidated Telegraph and Electrical Subway Company as to the payment of rent in advance by the former to the latter company. Judge Kelly said that the latter company was overcharging for rent and inspection, and he did not think his company ought to be compelled to pay a year's rent in advance and thus forced to lose interest on the money.

It was decided that the East River Company should pay one-fourth of its rent before October 10, and that the board would hold a special meeting within a few days to consider the question of modifying the rule to pay a year's rent in advance. The alleged overcharging for rent will be considered at the same meeting. A map was exhibited showing that the telegraph poles, except those of the Fire Department, have been taken down between Eighth and Fifty-ninth streets, and Third and Eighth avenues.

ELECTRIC LIGHTING IN PENNSYLVANIA COAL MINES.

THE H. C. Frick Coal and Coke Company, of Pittsburgh, Pa., the largest coal operators in the world, have just completed arrangements for the illumination of their many mines by electricity; in fact, the plans have already so far advanced that the lighting of two mining plants has been successfully accomplished. The contract for the work has been awarded to the Westinghouse Electric and Manufacturing Company, under whose supervision the work of installing the lighting plants was conducted. The first two mines to be lit by electric lights were the Leisenring No. 1 and Leisenring No. 2. The operation of the lights was commenced a few days ago. Everthing turned out to the greatest satisfaction of the Westinghouse and the Frick Companies.

The mines of the company are mostly situated in the Connellsville region, in Westmoreland and Cambria counties, Pennsylvania, and a number of them are shaft mines, varying in depth from one hundred to nearly one thousand feet. Owing to the accumulation of fire-damp and gas in many of these mines the lighting has always been a very grave problem, because almost every known method of illumination included the danger of causing the mine to catch fire. This led at last to the attempt of utilizing the electric current for lighting purposes. The wonderful success which was immediately established upon the first experiments is causing a rapid superseding of all other methods of lighting by electric illumination.

The Frick Company has adopted the method of lighting each mine independently, and at every mine is installed Westinghouse direct-current apparatus of sufficient capacity to light up the mine below and above the ground. The lamps are distributed underground throughout the main walks leading to the shaft. In addition, the tipple above ground, the engine house and other surface buildings are also lighted. The lamps vary from 16 to 50 c. p.

Electric light plants are now being put up at Leisenring No. 3, Trotter and Standard mine—the latter, by the way, is said to be the largest coal mine in the world—but it will probably take a whole year before the plants for all the mines are installed.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED OCTOBER 6, 1891.

Accumulators :—

Electrode for Secondary Batteries, W. A. Rosenbaum, 460,599. Filed Dec. 31, 1890.
Electrode consists of an envelope, a separate metallic frame within the same, and tablets of active material held in the frame.

Alarms and Signals :—

Central Station Apparatus for Call-Boxes, E. R. Wilder, 460,767. Filed Jan. 2, 1891.
Adapted for district messenger service and similar purposes.

Electrical Alarm, H. P. Smith, 460,895. Filed March 24, 1891.
For use in connection with lubricators, and designed to indicate the consumption of oil.

Conductors, Conduits and Insulators :—

Electric Conductor, W. Vogler, 460,606. Filed Nov. 9, 1889.
A double conductor; each wire embedded in an independent semi-cylindrical insulation; a reinforcing strip is interposed between the two insulations; an outer covering encloses the whole and binds it together.

Conduit for Electric Wires, W. Vogler, 460,607. Filed Feb. 25, 1891.
Sections are abutted together end-to-end and surrounded by a series of shields held in place by clamps.

Insulation for Electric Wires, J. R. Markle, 460,725. Filed Nov. 24, 1890.
Adapted especially for interior wiring, and relates especially to the means of junction between the conductors embedded in successive strips of insulating material.

Composition for Insulating Material, E. Thomson, 460,765. Filed Aug. 5, 1889.
Intended as a material which can be molded into form and to be fire or heat-resisting and to have great strength so that it can be drilled, tapped or otherwise mechanically worked.
Claim 1 follows:
An electrical insulating composition consisting of a fibrous mineral insulator as a base, a cementing insulating substance, such as rubber, and a lubricator consisting of an insulating material, as and for the purpose described.

Dynamos and Motors :—

Regulating the Speed of Electric Motors, M. J. Wightman, 460,614. Filed Feb. 28, 1891.
Adapted for constant potential motors; and consists in variably opposing the flow of current to the motor by coupling storage battery cells in the circuit leading through the motor, in various combinations.

Lamps and Appurtenances:—

Electric Arc Lamp, H. W. Libbey, 460,587. Filed Jan 12, 1891.
Relates to the class of lamps in which a disc carbon is employed for the positive electrode and a pencil carbon for the negative electrode. Relates to the manner of operating the electrodes.

Arc-Lamp Pencil, I. L. Roberts, 460,595. Filed March 10, 1890.
Employs a substance including chromium in its composition, in connection with a metal; the metal being either in the form of a tube enclosing the chromium compound or in the form a wire or rod surrounded or coated with the chromium compound. Upon the establishment of an arc between two such pencils the metal and the chromium compound fuse together and form smooth and highly infusible points.
Claim 1 follows:
A pencil for arc lamps, composed a of metal associated with a substance containing chromium, as set forth.

Electrode for Arc Lamps, I. L. Roberts, 460,596. Filed March 6, 1891.
Similar to the next above, but includes carbon with the chromium compound.

Electrode for Arc Lamps, I. L. Roberts, 460,597. Filed March 18, 1891.
Claim 1 follows:
In an arc lamp, the combination of an electrode composed of a conducting substance and a refractory non-conducting substance, substantially as described, and an electrode of carbon, as set forth.

Globe-Protector for Electric Arc Lamps, E. J. Openlander, 460,652. Filed Mar. 14, 1891.

Arc Lamp Electrode, H. W. Libbey, 460,680. Filed Oct. 17, 1890.
The positive carbon electrode is in the form of a hollow cylinder the lower end being cut in a spiral form; this positive carbon is rotated while fed downward.

Measurement :—

Millampere-Meter, L. D. McIntosh, 460,650. Filed Sept. 5, 1890.
Adapted especially for indicating currents employed in medical practice.

Metallurgical :—

Apparatus for Washing and Separating Gold and Silver from their Ores. W. J. Tanner, 460,722. Filed Sept. 24, 1884.

Miscellaneous :

Safety-Plug, H. P. Ball, 460,548. Filed Dec. 1, 1890.

Electric Switch, C. Wirt, 460,618. Filed Jan. 10, 1891.

Illuminating-Balloon for Advertising Purposes at Night, A. Gross, 460,674. Filed Apr. 25, 1891.

Electrically Controlled Cutting Device, LeR. S. White, 460,695. Filed Jan. 16, 1891.
An electro-magnetic device for controlling the application of a cutting-tool to the material to be cut at predetermined distances while fed through the cutting machine.

Automatic Safety Cut-Out, W. B. Cleveland, 460,701. Filed June 8, 1891.
Particularly applicable to circuits carrying large currents, such as light or power circuits.

Core for Electric Solenoids, J. T. Williams, 460,923. Filed Dec. 18, 1890.
Core is composed of a series of members of differing lengths and varying diameter, fitted one within the other in metallic contact.

Railways and Appliances :—

Turn-Out or Switch for Trolley Wires, D. W. Edwards, 460,571. Filed Oct. 2, 1890.

Ball Connection for Electric Railways, M. J. Wightman, 460,615. Filed May 15, 1891.
Designed to improve certainty of contact and to provide for the ready location of faults.

Trolley Wire Support, T. Fricker, 460,634. Filed Dec. 15, 1890.

Trolley Wire Support, N. Weeks, Jr., 460,735. Filed April 1, 1891.

Telegraph Block System of Railway Traffic Control, D. C. Coombes and W. Rowe, 460,771. Filed June 19, 1891.
Provides an automatic alarm at either end of a block section whenever a train or engine erroneously advances "against the block."

System of Electrical Signaling for Railroads, S. de Jager and A. Zoutman, 460,779. Filed April 25, 1891.
Designed to preclude collision between trains, whether moving in the same or opposite directions.

Underground Railway Conduit, E. E. Keller, 460,780. Filed April 13, 1891.
A conduit and devices providing for sectional or successive contacts between the working conductors and a continuous supply conductor.

Electric Railway Trolley, E. E. Keller, 460,781. Filed April 21, 1891.
Trolley includes a series of rolling parts so disposed that two or more of them will engage simultaneously with the trolley wire.

Automatic Electric Switch-Indicator, E. W. Hadley, 460,864. Filed Jan. 7, 1891.
Adapted for giving audible signals in case of a misplaced switch.

Electric Railroad, I. Robbins, 460,887. Filed Jan 19, 1891.
Employs a continuous main conductor and a series of resilient or self-returning wires connected to the main conductor, and which are successively picked up and let go by a drag connection attached to the moving car.

Telegraphs :—

Printing Telegraph, M. G. Farmer, 460,572. Filed May 15, 1891.
Primarily an improvement upon the same inventor's telegraph patented July 22, 1856, No. 15,378. The present system, however, employs induction coils, secondary currents only being employed upon the main line.

Steno-Telegraphic Apparatus, A. Wood, 460,619. Filed Dec. 7, 1886.
For the telegraphic transmission of phonographic symbols.

Message-Recording Instrument, A. Storer, 460,676. Filed Jan. 27, 1891.
A signal register or recorder.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The Advertiser as well as the Farmer may reap great harvests if he will.

HALE & ADAMS.

THIS firm, composed of Willis G. Hale and Samuel F. Adams, formerly with the Edgemoor Iron Company, of Wilmington, Del., has recently been organized, with headquarters in New York and Philadelphia. They will carry on the business, not only of architects but also of consulting and constructing electrical, mechanical and civil engineers. Mr. Hale's work in Philadelphia, architecturally, is well known, such buildings as the Widener mansion, the Bingham House, the Union Trust Building, the Hale Building (formerly the Keystone Bank), and many others having been designed and built by him. Mr. Adams is perhaps best known in connection with his work on the Chicago Edison Central Station, the Rookery Building, the Omaha *Bee* Building, the St. Paul *Pioneer Press* Building, and the Chamber of Commerce Safety Vaults in Chicago, although his more recent operations have been in the South. This firm already have on their books the plans for a 14-story building on lower Broadway, New York, to cost $1,500,000, besides plans for numerous other buildings. They expect to make quite a feature of the electrical business, and are perhaps the first firm of architects to make this departure. The 14-story building, before referred to, is to be heated exclusively by an electric system of heating designed by Mr. Adams, and is to have 6,000 incandescent lights and 40 arcs. This will be the first building in the world heated throughout by electricity.

WIRING OF THE MASONIC HOME, UTICA, N. Y.

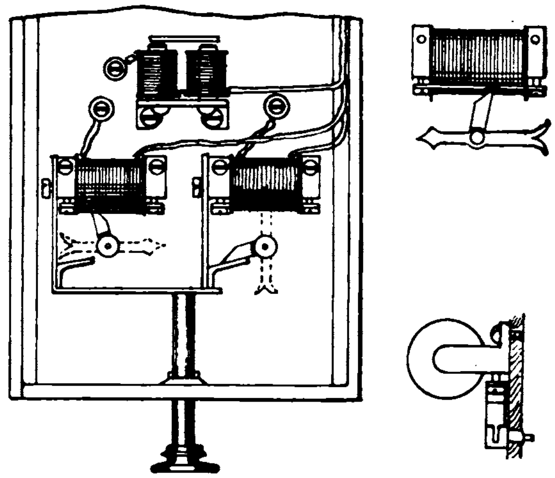
MR. W. H. HUME, of this city, the architect of the new Masonic Home, at Utica, N. Y., has designed a building 250 feet front by 200 feet deep, which, in point of completness and thoroughness of detail, is a credit even to one of his eminence in the profession. The building is, of course, electrically lighted throughout, the contract having been awarded to the Utica Electric Light Co., who propose to make their work correspond in excellence with that of the architect. Grimshaw white core wire is to be used, and will be placed in "Vulca" ducts, but one wire being contained in each tube.

The success of the "Vulca" ducts has been remarkable since their introduction a short time ago, and orders are now being received from all parts of the country. "Vulca" is also being used quite extensively as a substitute for hard rubber, and a large amount has already been sold for that purpose.

THE UNION GRAVITY ANNUNCIATOR.

DURING the past six months the Union Electric Works, of Chicago, have been experimenting upon annunciators with a view to producing one which should be perfectly accurate, require very little current, would not be likely to get out of order, and that could be furnished at a low price.

The accompanying illustration shows the results finally arrived at, and will be readily understood. The armature suspended from the poles of the single magnet rests upon the heads of the screws which pierce it. Drawn to the poles by the action of the electric



UNION GRAVITY ANNUNCIATOR.

current, it at once falls back to its normal position when the pressure upon the push ceases. The latch which is connected with the needle falls immediately when the armature is drawn up, and is caught upon the projection from the replacing mechanism. This mechanism is operated by pushing upward upon the knob below the case, and it also drops back into place by its own weight. There are no springs to get out of order, and nothing is liable to to wear out for years. These annunciators are handsomely encased in oak, walnut, Georgia pine and cherry.

THE ALEXANDER-CHAMBERLAIN ELECTRIC CO.

MR. HARRY ALEXANDER, well known to the electrical fraternity through his connections with the Thomson-Houston Electric Co., as well as with other companies, has found his business increasing to such an extent that he has taken a partner in Mr. Rufus N. Chamberlain. They will do business under the firm name of the Alexander-Chamberlain Electric Co. Mr. Chamberlain has also had great experience through his connection with the Sawyer-Man Electric, Julien Electric Traction, and other companies. This company intends to make a specialty of automatic isolated plants for private houses, as well as inspection of all kinds of electric plants. All kinds of electric work will receive their prompt attention. Mr. Alexander has been doing a good deal of this work. Both members, having had much experience with storage batteries, will be in a position to install most thorough and complete accumulator plants for light and power for launches as well as buildings. The new field of electro-deposition will receive their special attention.

MR. W. A. GILES.

MR. W. A. GILES, electrical and mechanical engineer, recently with the Edison General Electrical Co. in the Marine and Mining Department, will in the future conduct an engineering and equipment business with headquarters at Pittsburgh, Pa.

Mr. Giles is also an expert in ventilating and drying in all its applications. He has been appointed selling agent for the J. T. Case Engine Co., of New Britain, Conn., makers of the Case automatic high-speed engine ; L. J. Wing Co,, New York, disc exhaust fans,engines and motors fans, etc. ; and the Exeter Machine Co., Exeter, N. H., blowers, exhausts, etc.

H. WARD LEONARD & CO.

A VERY neat little phamphlet has been issued by the above firm on the value of the services of a consulting electrical engineer to persons investing in electrical plants. It is full of good points and useful hints.

THE ELIESON SYSTEM AT NEWARK, N. J.

MR. C. P. ELIESON is to put his system of storage battery traction in operation at Newark, N. J., and has let the contract for motors, &c., to the Detroit Electrical Works, of Detroit, as he considers the Rae motor the best for such work.

J. H. BUNNELL & CO.'S POCKET GALVANOMETER BATTERY GAUGE.

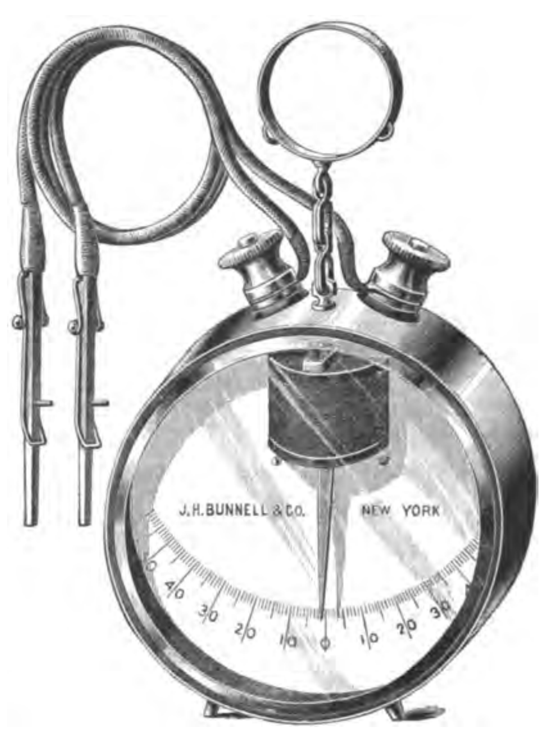
THIS consists of a pocket galvanometer of such construction and calibration as to furnish a reliable standard for practical measurement of current strengths, in testing from one to five cells of ordinary batteries, such as the various forms of sal-ammoniac, sulphate of copper and acid batteries. The reading is such that a good Leclanché cell indicates about 9°; Burnley dry battery, 14°; Lockwood American District (blue vitriol) 6°; Crowfoot Western Union form, 8°.

As these gauges are all calibrated to a single standard, and are made exactly alike, their introduction furnishes an accurate instrument for comparisons, or condition tests, of from one to five cells. The gauge being a true galvanometer, and not dependent for its action on springs or electromagnetic devices, its indication is always the same for a given force.

The "Galvanometer Gauge" is arranged for use either standing upright on instrument, table or desk, or as when used for miscellaneous testing in a battery room, etc. It is held suspended by the chain and ring, in which position, without current, the needle hangs at zero, the same as it would if the galvanometer were standing on a table.

These gauges are especially advantageous for use as permanent circuit indicators for fire-alarms, burglar-alarms, district telegraphs, etc., on account of their presenting the face of the instrument in upright position. For all the purposes for which it is available, one particular feature of its practical merit consists in the fact that the action of the needle is perfectly "dead beat" (that is, the needle moves at once to whatever indication the current calls for and remains there without oscillation as long as the current continues). The dead-beat movement is usually to be found only on the most expensive galvanometers.

Two silk-covered conducting cords are attached to each gauge, and these cords are provided with a very convenient form of im-



BUNNELL POCKET GALVANOMETER BATTERY GAUGE.

proved "tip," which is so made that it can enter any ordinary binding post and be held by the binding screw in the usual way, or, being a square-end tip, is suitable for English binding posts. Also having a spring clamp, it can be hooked firmly to bare wire (office wire size or less) at any exposed point. This form of tip is extremely handy in all experimental temporary wire connecting, and by its use with the gauge the condition of any one to five cells in the middle of the series can be instantly ascertained without making breaks and reconnecting.

NOVEL FORMS OF MINIATURE SOMOFF INCANDESCENT LAMPS.

THE illustrations herewith present some of the novel and useful forms of miniature incandescent electric lamps which have just been placed on the market by J. L. Somoff, of No. 1 Ann street, New York City, who makes a specialty of their manufacture.

Fig. 1.–Grain Lamp.

Fig. 1 is a "Grain lamp"—the smallest incandescent lamp ever made. Compared with the well-known "Pea"—the next larger size lamp to it—the "Grain" is smaller than its rival by 1/16 inch in diameter and 1/8 inch in length. The exact dimensions are: 3 mm. diameter and 5 mm. long.

In medical practice, where electricity is acquiring an ever-growing application, this lamp, thanks to its very small size, has made it possible to thoroughly inspect the bladder and the stomach, principally the former, into which it is introduced. The use to which such a lamp can be put was illustrated at the Centennial Exhibition by a fish, swimming in an aquarium with a lamp brightly glowing in his stomach. The electromotive force required by those lamps is high, the filament being exceedingly thin. Twelve volts, with a current of but 2 amperes, gives a light of about 1 c. p., and the little globe heats up to no more than the temperature of the body. The very low current required by the lamp makes it suitable for use with Prof. Barrett's well-known chloride of silver medical batteries.

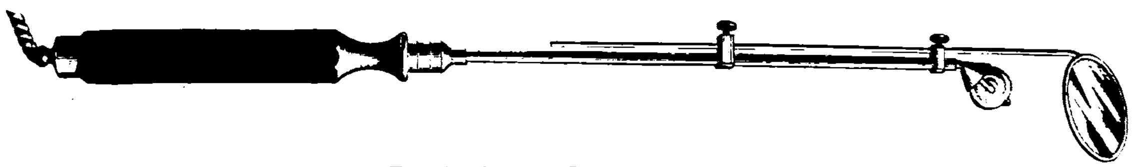


FIG. 2.—SOMOFF LARYNGOSCOPE.

Fig. 2 presents the same lamp mounted in a laryngoscope, which, likewise possesses some novel features, inasmuch as, excepting the hard rubber handle, and the glass of the lamp and of the mirror, the entire instrument is electro-plated with platinum. This feature is of much value in treatment of infectious diseases. The lower half of the lamp is encased in a platinum cup, to which the glass is fused, the cup being screwed on to the instrument.

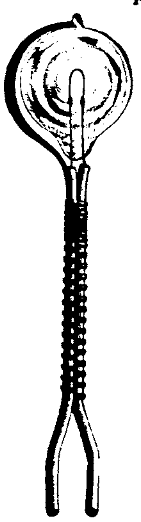


Fig. 3.—Tulip.

Fig. 3 is a "Tulip lamp" mounted upon two bare copper rods, wound over with a thread of silk. The thread serves to insulate the rods from each other as well as to keep them firmly together. A spring attached to one of the rods loops over the "tip" of the lamp and holds it in position.

The copper rods fit the handles or sockets now almost universally employed in connection with electric cauterizing knives, and a doctor working with a cauterizing knife, can in an instant replace it by a lamp, should this become necessary, for instance, in cases of diseases of the mouth. The lamps are of 3.6 volts, to suit the battery employed in electro-cauterization—usually two cells of plunge bichromate pattern.

Fig. 4 is a unique form of lamp, combining a lamp globe of "German" or "Bohemian" glass with a bull's eye or concavo-convex lens, hence called the "Bull's Eye" lamp. On the side of the globe opposite the lens is a platinum mirror, which is formed by precipitating this metal from its chloride at a red heat. The finely divided metal united with the glass by fusion presents a beautiful reflector, which remains always clean and bright.

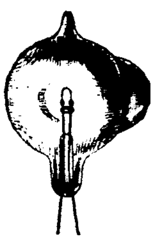


Fig. 4.—Bull's Eye.

The advantages of such a lamp over any other in an electric lantern are evident. The luminous filament is in the focus of both the lens and the reflector, which arrangement greatly increases the amount of effective light, notwithstanding the imperfections of the lens which, of course, is neither cast in a mould nor ground. And, moreover, if made of very heavy glass, it renders useless the glass dome (serving the double purpose of protecting the lamp and as a lens) with which all English miners' lanterns are equipped.

MR. J. C. KEEFE has resigned as secretary of the Syracuse, N. Y., Electric Light Co. Mr. Manning C. Palmer is acting in his stead.

A LIST OF THE SHORT SYSTEM ELECTRIC ROADS.

WE give below a list of roads equipped entirely or in part by the Short Electric Railway Company:

Watervliet Turnpike and Railway Co., Albany, N. Y., 2 motors; Battle Creek Street Railway Co., Battle Creek, Mich., 2 dynamos, 12 motors; Braddock Electric Railway Co., Braddock, Pa., 6 motors; Bristol Belt Line Railway Co., Bristol, Tenn., 1 dynamo, 6 motors; Coney Island & Brooklyn R. R. Co., Brooklyn, N. Y., 2 motors; Broadway & Newburg Street R. R. Co., Cleveland, O., 23 motors; Brooklyn Street R. R. Co., 2 motors; So. Covington & Cincinnati Street R. R. Co., Covington, Ky., 5 dynamos, 36 motors, 10 miles; Georgetown & Tennallytown Railway Co., Georgetown, D. C., 4 motors; Harvey Transit Company, Harvey, Ill., 6 motors; Fred. T. Evans, Hot Springs, S. Dak., 1 dynamo, 4 motors, 1.25 miles; Huntington Electric Light & Street Railway Co., Huntington, W. Va., 1 dynamo, 6 motors, 3.5 miles; Citizens' Street Railway R. R. Co., Indianapolis, Ind., 12 motors; Jamestown Street Railway Co., Jamestown, N. Y., 3 dynamos, 30 motors, 12 miles; Johnstown Passenger Railway Company, Johnstown, Pa., 3 dynamos, 20 motors; Lincoln Street Railway Co., Lincoln, Neb., 40 motors; Central Passenger Railway Co., Louisville, Ky., 4 motors; Muskegon Railway Co., Muskegon, Mich., 5 dynamos, 36 motors, 13.5 miles; Pittsburgh & Birmingham Traction Co., Pittsburgh, Pa., 40 motors; Pittsburgh Traction Company, Pittsburgh, Pa., 1 dynamo, 4 motors, 2 miles; Schuylkill Electric Railway Company, Pottsville, Pa., 4 dynamos, 20 motors, 6 miles; Rochester Electric Railway Co., Rochester, N. Y., 4 motors; Rochester Railway Co., Rochester, N. Y., 11 dynamos, 100 motors, 55 miles; West End Street Railway Co., Rockford, Ill., 1 dynamo, 6 motors, 4.5 miles; Lindell Railway Company, St. Louis, Mo., 4 motors; Wilkesbarre & Wyoming Valley Traction Co., Wilkesbarre, Pa, 2 dynamos, 36 motors, 16 miles.

AMERICAN INSTITUTE FAIR NOTES.

THE Sixtieth Annual Fair of the American Institute opened in their building on Third avenue, Sept. 30th. Among the interesting exhibits are the following:

JOSEPH MEIER, 34 Ferry street, New York, patent friction pulley and means of transmitting power.

UNITED STATES ELECTRIC ILLUMINATING CO., dynamos running 102 arc lamps for lighting the hall.

THE MATHER ELECTRIC CO., dynamos, incandescent, running 600 16 c. p. and 32 c. p. for lighting the hall.

THE C. & C. ELECTRIC MOTOR CO. exhibit a generator running Blackman fan motors.

VOLNEY W. MASON, Providence, R. I., exhibits a large assortment of friction clutches.

THE BLACKMAN FAN and Solano steam engine combined are exhibited by Howard & Morse, 45 Fulton street, New York.

A. J. WEED & CO., 106 Liberty street, New York, exhibit model dynamos designed for students and amateurs.

THE TANITE EMERY CO., Stroudsburg, Pa., exhibit a large assortment of emery wheels, &c.

THE BRISTOL RECORDING STEAM GAUGE is exhibited by the Bristol Mfg. Co., of Waterbury, Conn.

THE COLWELL LEAD CO., 63 Centre street, New York, exhibit a number of their specialties.

THE H. W. JOHNS CO. have a large exhibit of their Vulcabeston specialties.

THE STANDARD PAINT CO. have in place their exhibit lately at the Montreal Convention, showing their P. & B. paints, &c.

CHARLES A. SCHIEREN & CO. exhibit leather link belting, &c., and a sample of the largest belt in the world.

THE NEW YORK LEATHER BELTING CO., 86 Gold street, New York, exhibit leather belting, &c.

THE DAVIS ELECTRIC TRACK SCALES are exhibited on the eastern platform, &c. They were described in THE ELECTRICAL ENGINEER of Sept. 30.

FRANK W. GATES, 39 Dey street, New York, exhibits a large variety of sectional ladders adapted for linemen, wiremen, &c.

ST. LOUIS NOTES.

THE HAZELTINE ELECTRIC COMPANY was represented at the recent exhibition at St. Louis, by its general manager, Mr. C. W. Hazeltine—one of the many naval officers who have drifted into the electrical business. Mr. Hazeltine had on exhibition his carbon protector, the claim for which is the doubling of the life of carbons in ordinary arc lamps. By this device, without any change whatever in the lamp, and without any attention during the interval, a single arc lamp can be made to burn for fourteen hours, and a double lamp for from 28 to 30 hours. The central station men at the Convention showed much interest in this device, which bids fair to save them much money.

THE EMERSON ELECTRIC MANUFACTURING CO. are bringing out an alternating current motor for driving sewing machines. By a simple attachment to the regular foot treadle the speed of the motor is regulated from the slowest speed required for intricate work up to the highest speed permissible for straight seam work. The machine responds almost instantaneously to the action of the regulator; the operator has more thorough control over the speed of the machine than is possible with foot power. The regulating device is operated by simply pressing the foot treadle down against the action of a retractile spring; the farther it is depressed the greater the speed.

MR. G. PANTELEONI, representing the Westinghouse Electric Co., reports the sale of two 400,000 watt alternating generators to the Missouri Electric Light & Power Co., St. Louis. These generators are compound wound and self-regulating, and are the largest in the United States, the two having a combined capacity of 20,000 lights. Contracts have also been closed for 1,500 lights for Hot Springs, Ark., and 1,500 lights for San Luis Potosi, Mexico. The 650 light plant at Venice, Ill., has been put into operation; also the electric railway at Cairo, Ill., consisting of six cars with an 80 h. p. generating plant.

W. D. BOYCE & CO., 1234 Clark Ave., have taken the agency for the Porter-Allen engines manufactured by the Southwark Foundry and Machine Co., Philadelphia, and have made the following sales: The Lindell Railway Co., one 400 h. p. and four 250 h. p.; the Missouri Railway Company one 100 h. p. They will have one of their 100 h. p. engines on exhibition in the exposition building during the annual exposition which opened Wednesday, Sept. 2d.

WESTERN NOTES.

THE SPERRY ELECTRIC MINING MACHINE CO., 39th street and Stewart avenue, Chicago, are placing on the market a superior fuse wire which is meeting with most excellent success on account of its many good qualities. The company's extended experience in adapting electrical machinery to mining and railroad work, and furnishing supplies for arc and incandescent lighting, convinced them that there was a pressing demand for a more accurate system of fuse wire. As fuse wire is directly in the line of electrical supplies and specialties, they decided to go into its manufacture extensively, and have now prepared, after a series of careful tests, a full and complete supply, which may be relied on absolutely for correctness of carrying capacity and uniformity of sizes and alloy. This wire is calculated for all classes of work, being just the thing in small sizes for ceiling rosettes and fuse boxes, while the heavier grades will insure against burn-outs in mining and railroad service. All sizes are kept constantly on hand in large and small quantities to suit the requirements of all classes of buyers.

JEFFERSON CITY, MO.—At the last session of the Missouri State Legislature, provision was made for the establishment of a Manual Training School, or Industrial Department, in connection with the Lincoln Institute, at Jefferson City, Mo. The necessary buildings are nearing completion, and the power plant, tools, etc., will be installed in a short time. The board has contracted with the Pond Engineering Company, of St. Louis, for a thoroughly first-class power plant, designed in accordance with the best principles of modern steam engineering, as the educational value of such a plant will be an important consideration. The order covers an Armington & Sims engine, horizontal tublular steam boiler, with rocking grates, Lowe feed-water heater and purifier, and Blake boiler feed pump. The Pond Engineering Company are to deliver and erect this machinery at the institute complete and ready for regular service

THE ELECTRIC MERCHANDISE CO., No. 11 Adams st., Chicago, dealers in electric railway supplies exclusively, report business as very brisk, and are filling large orders for equipment of all kinds right along. Their catalogue of street railway apparatus, together with the supplement, just issued, form a most valuable work on the details of equipment for electric roads, and show all the latest and most improved devices. The Burton Electric Heater, for which the company are the general agents, is being very largely introduced, and is attracting universal attention.

THE HANDSOME EXHIBITION at the Institute of Building Arts 65 Washington Street, Chicago, of Kohler Bros. & Grier, the Western representatives of H. T. Paiste and the Eddy Electric Mfg. Co., has been greatly admired by the architects of Chicago. The offices of this firm are at 341 "The Rookery." They also have a large wareroom on the West Side, and a stockroom in the immediate vicinity of their office. They carry a large assortment of motors, and a full stock of sockets and switches, and are a main distributing house for the factories which they represent.

THE KNAPP ELECTRICAL WORKS are having a large demand for their Thomson-Houston and Sawyer-Man sockets. This socket is very simple in design, and there is absolutely no danger of a short-circuit. One of their salesmen recently booked an order for five thousand before they were ready for the market. The firm are now having a large supply made up, and can fill all orders promptly. They have laid in a large and complete stock of Perkins lamps of all candle-powers and voltages for the fall trade.

ERIE BALL ENGINES.—The Bloomington Electric Light Co., Bloomington, Ind., are about to install a 150 h. p. Ball engine, manufactured by the Ball Engine Company, Erie, Pa. This company are also installing an 80 h. p. engine in the Hebrew Institute, New York City, through their representative, E. T. Copeland, 106 Liberty street, New York City. The Dubois Traction Passenger Railway Co., Dubois, Pa., are likewise installing a 100 h. p. Erie Ball engine, and sold them by Dravo & Black, Pittsburgh, representatives of the Ball Engine Company, in that district.

THE KNAPP ELECTRICAL WORKS, 54 Franklin street, Chicago, report an increasing demand for "Safety Seamless" rubber wire. They have laid in a large stock of Perkins lamps to meet the fall trade, and from all indications their lamp trade will be larger than ever the coming year. They have also recently placed upon the market a new socket. This socket is very simple in design and complete in construction, and it is said there is absolutely no danger of a short circuit.

NEW WESTINGHOUSE ELECTRIC ROAD.—The Westinghouse Company have just completed the equipment of the Windsor & Sandwich Street Railway, at Windsor, Canada. Six closed cars and four open ones are now in operation. Two of the closed cars are equipped with double motors and the others with single. The road is a great success and every one is delighted with the advent of rapid transit.

THE ILLINOIS ELECTRIC MATERIAL CO., through Mr. E. L. Clark, secretary of the company, have secured an order for the line material for an extension of 150 arc lights to be added to the plant of the Jenney Electric Light and Power Co., of Peoria, Ill. The electric road which this company has been constructing at Cairo, Ill., was started on the first of the month and is a great success.

THE FALLS RIVET & MACHINE CO., of Cuyahoga Falls, Ohio, have just issued a most extensive and complete catalogue of their power transmission machinery and other products. It is beautifully gotten up, replete with handsome illustrations and contains a fund of the most useful and valuable information. This company manufacture shafting, pulleys and clutches, and are doing a large business with the central stations everywhere.

THE CHICAGO ELECTRIC MOTOR CO., Springer Building, Chicago, are making a specialty of repair work at reasonable prices. This will interest street railway men and other operators of electrical machinery who require armatures and fields rewound. They have made a special department for this work, which is done by experienced men, and satisfaction is guaranteed.

THE BURTON ELECTRIC COMPANY, through their selling agents, the Electric Merchandise Company, of Chicago, report sales of the Burton Electric Heater to the West End Road of Boston (20 cars) Jamestown, N. Y., Newburyport, Mass., Spokane Falls, Wash., New Albany, Ind. and Sioux City, Iowa. These heaters have passed satisfactorily the expertmental stage, and are to-day a fully demonstrated practical and commercial success.

THE ELECTRIC MERCHANDISE COMPANY, Chicago, report a very large business during the last month, both in orders for complete equipments of new roads, and also for a large number of extensions. The well-known standing of this company is a guarantee to would-be purchasers that material offered by them will be found satisfactory in every respect.

THE UNION ELECTRICAL WORKS, Springer Building, Chicago, are turning out a very large number of their new bells, which are meeting with a ready sale and the approval of both dealers and buyers wherever they have been used. They will shortly put on the market a new form of annunciator, possessing some important advantages.

MR. GEORGE CUTTER is sending out large batches of Simplex wire, most of it going to places where a number of prominent wires had been carefully tested.

THE SIOUX CITY ENGINE WORKS, of Sioux City, Ia., have issued a large "reminder" to hang upon the wall, illustrating the engines and boilers manufactured by them. Among these are the Sioux City Corliss, Gidding's automatic and compound engines, and the Stirling water-tube safety boiler. The factory of this company has a capacity for turning out 20,000 h. p. annually, and is the largest west of the Mississippi.

MR. J. C. LIGGETT, who has been for some years past associated with the Westinghouse Co. and later with the Edison Illuminating Co. in Milwaukee, Wis., and is well known in electrical circles in the West, has accepted a position with the Standard Electric Co., of Detroit, as general superintendent of the company, who are manufacturing a new storage battery for all classes of work.

THE CHICAGO OFFICE of the Pond Engineering Company has just contracted to furnish two 60 h. p. Armington & Sims engines with foundation boxes to the gas works of Chicago. One of them goes into the north station of the Peoples' Gas Light & Coke Co., and the other into the south station of the Chicago Gas Light Co. Both will be used for driving blowers.

JOHN R. MARKLE, of the Electrical Fibre Carbon Co., Detroit, spent a week, recently, in Chicago, and made several large contracts for carbons for battery and other purposes. Mr. Markle is a pioneer, one of the best-known men in the electrical business, and under his management the Electrical Fibre Carbon Company will achieve success in a high degree.

MR. THOMAS C. RAFFERTY, the assistant general manager of the Great Western Electric Supply Co., reports business as very flourishing with his company. In some of his recent trips in the interest of his house he states that he secured several large orders for railway line material and general supplies for construction work.

THE GLEASON & BAILEY MANUFACTURING CO., 233 Lake street, Chicago, manufacturers of gas and electric light fixtures and supplies, have recently added a full line of electric supplies, in which department they propose doing considerable business. They are also taking hold of good specialties, amongst others, the Steuben incandescent lamp, for which they are finding a ready sale.

MR. ARCHER TURNER, a young English electrical engineer, is making Chicago a visit. He has been connected for some time with the Brush Company, in London. Mr. Turner will probably ally himself with some of the parent companies in this country, where he proposes remaining for some time.

J. LANG & CO., 44 Michigan street, Chicago, are busy turning out switches for large and small currents. They have acquired quite a reputation for the excellence and beauty of their goods, which never show any signs of heating or arcing, even under the severest conditions.

MR. GILBERT G. M. MCDUFF, who for the past year and a half has been the general Western representative of the Fred. H. Whipple Co., with offices at 407 "The Rookery," Chicago, has severed his connection, and will probably take hold of some other electrical journal.

MR. GEORGE D. SHEPARDSON, whose appointment as Professor of Electrical Engineering at the University of Minnesota was recently noted in THE ELECTRICAL ENGINEER, stopped in Chicago recently, and inspected some of the local electrical works on the way.

THE ELECTRIC MERCHANDISE CO. are very busy shipping orders for electric street railway equipment. This well-known company are furnishing supplies to almost every street railway plant in the country, and also shipping goods abroad.

THE SALT LAKE CITY POWER LIGHT & HEATING CO. have found it necessary to make a large increase in their power plant, and have ordered two additional Armington & Sims engines from the Pond Engineering Company, St. Louis.

THE CENTRAL ELECTRIC CO. are doing their usual large amount of business, and orders for Okonite, Packard lamps, and other specialties for which they are agents are coming in all the time.

MR. EARNEST HOEFER, of the Illinois Electric Material Co., has returned from his trip East, and is pushing for business in his wonted energetic manner.

MR. C. E. LEE, formerly with the Great Western Electric Supply Co., will open an office in Chicago as representative of the Electric Gas Lighting Co., of Boston.

CHARLES A. BENTON, the manager of the railway department of the Detroit Electrical Works, spent a day in Chicago recently.

PHILADELPHIA NOTES.

THE THOMSON-HOUSTON ELECTRIC LIGHT CO., 509 Arch street, report recent installations from their office as follows: Conneaut Electric Co., Conneaut, O., 650 incandescent; Columbia Electric Light Co., Columbia, Pa., 50 arc and 650 incandescent; Shamokin Street Ry. Co., Shamokin, Pa., 50 arc and 650 incandescent; Frackville & Gilberton Electric Co., Frackville, Pa., 50 arc and 650 incandescent; Butler Electric Co., Butler, Pa., 1,300 incandescent (local company, new); Indiana Electric Co., Indiana, Pa., 80 arc and 650 incandescent; Pencoyd Iron Works, Pencoyd, Pa., 450 incandescent: A. B. Farquhar & Co., York, Pa., 300 incandescent; Bethlehem Electric Co., Bethlehem, Pa., 50 arc; Bethlehem Iron Co., Bethlehem, Pa., 50 arc; Baltimore & Ohio R. R. Baltimore, Md., 50 arc; Hughesville Electric Co., Hughesville, Pa., 20 arc and 500 incandescent; Bala & Merion Electric Co., Bala, Pa., 1,300 incandescent; Atlantic City Gas & Water Co., Atlantic City, N. J., 50 arc; Home Electric Co., Tyrone, Pa., 100 arc: Camden Electric Co., Camden, N. J., 50 arc; Milton Electric Co., Milton, Pa., 100 arc; Schuylkill Haven Electric Co, Schuylkill Haven, Pa., 50 arc and 650 incandescent; Jermyn Electric Co., Jermyn, Pa., 30 arc and 650 incandescent. The company also reports the sale of 45 motors ranging from ¼ to 5 h. p.

THE ARNOLD ELECTRIC MANUFACTURING CO., of Chester, Pa., has secured a contract from the U. S. Government for four electric fan blowers, and four motors to be used on the new cruisers "Texas" and "Main." They also supply these vessels with the new Navy standard sockets and special waterproof junction boxes.

MR. C. F. COLE, who for some time past has been a salesman in the isolated lighting department of the Thomson-Houston Electric Lighting Co., of this city, has severed his connection with that company, and accepted the position as general agent for the La Roche Electric Works.

NEW YORK NOTES.

TRUEX & VAIL, of 136 Liberty street, New York City, received a large order from the Pittsburg Gas Light and Coke Company, of Pittsburg, Kansas, on the 24th inst., for their "Swinging Ball" lighnting arrester, and were informed that the company had suffered to the extent of five hundred dollars during the month of July from lightning, and had now decided to equip the plant with this lightning protector, in order to be on the safe side hereafter.

THE T. & L. R. R. are still hampered in extending their lines by the non-arrival of material. They have now put a few men at work, and those are principally engaged in setting poles along the new routes. Unless the switches and curves reach Troy very soon the work will necessarily be delayed until spring.

THE INTERIOR CONDUIT AND INSULATION CO. will be represented at the street railway convention, at Pittsburgh, by President E. H. Johnson and Mr. E. T. Greenfield, its electrician. The company will show its improved method of burying the feeder wires of electric railways; also its new junction box.

HON. CHARLES CLEMINSHAW has resigned the presidency of the Troy City Railroad. Reasons alleged are that his private business and the presidency of the Troy & Lansingburg R. R. Co. demand all his attention. The vacancy will probably be filled at the October meeting of the trustees.

THE WENSTROM CONSOLIDATED DYNAMO AND MOTOR CO., through their New York agents, have shipped a 450 light direct-current dynamo for an isolated plant in Montreal.

THE W. S. HILL ELECTRIC COMPANY.

THE W. S Hill Electric Company of Boston, have purchased from Mr. W. S. Hill all of his electrical inventions for electric motors, dynamos, lamps, switches, etc., and will at once enter largely into the manufacture of these goods.

The new men coming into the company are Geo. A. Denham, of Sioux Falls; Geo. H. Poor, of Chicago, Geo. F. Gould, of Portland, Me., and Louis F. Busiel, of Laconia, N. H.

These, with Mr. Hill and his son, Louis E. Hill, will constitute the board of directors. Mr. Denham will be treasurer, and Mr. Poor general manager. W. S. Hill is president of the company, and Louis E. Hill will attend to the manufacturing department.

The office of the company will for the present be located at No. 54 Devonshire street. The present factory will be enlarged, and the company will enter at once into the manufacture of small dynamos, for which Mr. Hill has acquired an extended reputation.

Hill's double pole switches, station switch, arc lamp and switchboard apparatus, with various other electrical apparatus, will constitute the electrical goods handled by the new company.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

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THE CENTRAL POWER STATION OF THE WEST END STREET RAILWAY COMPANY, OF BOSTON.

BY

A. C. Shaw.

I.—INTRODUCTORY.

MUCH has already been written about the wonderfully rapid development of the electric street railway since it first began to attract commercial attention by its practical successes. It is not my purpose in the present article to follow the history of the electric car from the beginning of the year 1888, the year in which it may be said the electric car first became a commercial success, when there were barely a dozen roads in the United States, having an aggregate mileage of about 50 miles, being operated by electricity, with about 100 cars, down to the present day, when there are over 350 roads, operating nearly 3,000 miles, with over 4,500 cars. A visit to any of these roads will prove that electric cars are being run sucessfully, but nothing will bring home to the mind of the inquirer so forcibly the vast hold that the electric railway has upon the people of this country, and the immense prospects of its universal adoption for street railway purposes as a visit to one or other of the enormous central stations being erected in various cities for street railway work. To a certain extent electric lighting has reached its limit, in the way of new franchises, though not in the way of new work. Almost every town of any size in the United States has one or more central stations, lighting up the streets and providing commercial and house lighting. There are, however, very many street railway companies who have as yet not adopted electricity as a motive power, and it is to this branch of the business that most attention is being given by electrical engineers at the present day. A description of the largest central power station in the world will therefore, it is believed, prove interesting to every one connected with the electrical business, and it is my purpose in the following article, to describe in detail the station which is now being built by the West End Street Railway Company, of Boston, a station the immensity of which can hardly be appreciated without an actual visit, and which certainly places Boston in the front rank as a city electrically equipped with street railways.

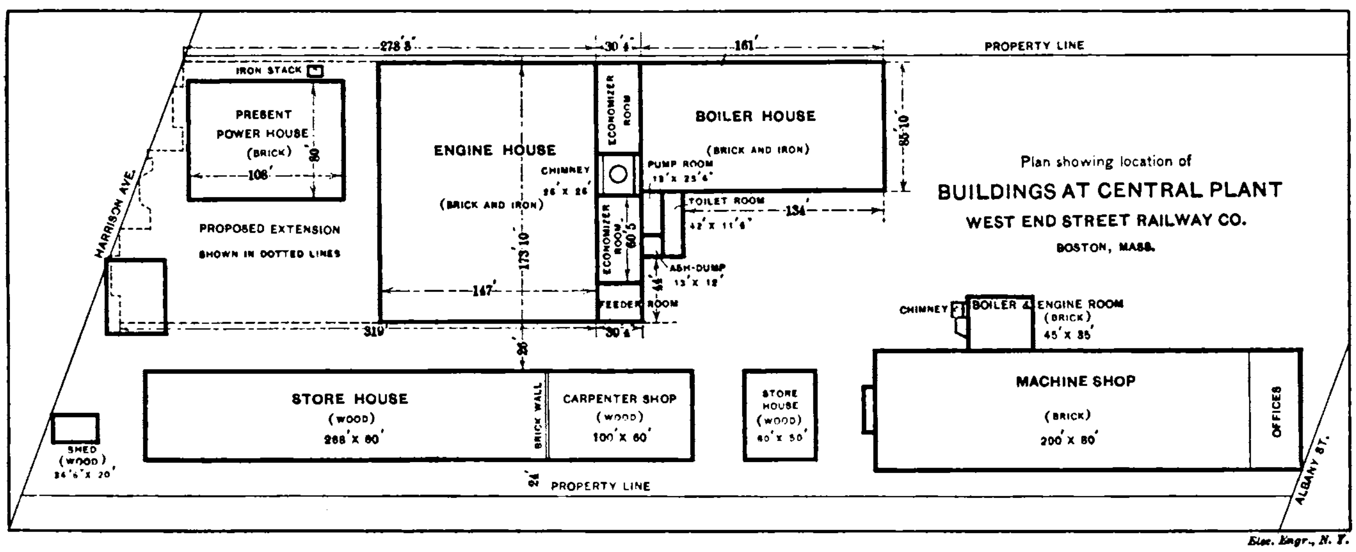


FIG. 1.—GENERAL PLAN OF THE BUILDINGS.

II.—THE HISTORY OF THE ROAD.

A few words as to the history of the company may be found interesting. The West End Street Railway Company was organized November 12th, 1887, with a capital of $80,000, and with Mr. H. M. Whitney as president, for the purpose of building a short line to Brookline, so as to develop the land of the West End Land Company, there being at that time several other street railway companies operating in Boston. Soon after the franchise was granted, before any construction was done, consolidation of the several companies was talked of, and in 1888, finally, a consolidation was effected, the companies consolidating being the West End Company, the Metropolitan, the Cambridge, the Boston Consolidated, South Boston, the Charles River and the Somerville, the only one left out being the Lynn and Boston Railroad, which still exists. At the time of the consolidation there were required about 7,816 horses and 1,480 cars, and the company was started with a capital of $6,000,000 preferred stock, $1,500,000 common stock, and $1,500,000 outstanding bonds which the West End Company assumed. Business increased so rapidly that a year later there were as many as 9,000 horses and 2,000 cars, and some other form of motive power was investigated, and much time and money was spent in making complete plans and estimates for equipping Boston with cable roads. About that time Mr. H. M. Whitney was invited by the Sprague Company to go to Richmond, Va., and investigate the merits of the electric road in that city, and so impressed was he with the great possibilities of the electric car, as foreshadowed in Richmond, that it was at once decided to abandon the cable project and equip a portion of the road with electricity as a practical experiment. In the summer of 1888 a contract was made with the Sprague Company, and on January 1st, 1889, 20 cars were started, running from Park Square to Chestnut Hill and Allston, with the overhead system, the line from West Chester Park to Park Square being operated by the Bentley-Knight underground conduit, this underground part of the work being afterwards abandoned. A month or so later the Thomson-Houston Electric Company started 20 cars of their manufacture from Bowdoin Square to Harvard Square, these being operated by themselves for the first six months until their success was fairly demonstrated, and they secured from the West End Company an order for 600 motors. This was really the commencement of the large Thomson-Houston system now in operation by the West End Company in Boston. It is worthy of note that so well pleased were the citizens with the electric cars that when the West End Company went before the Board of Aldermen for a franchise for pole rights for 180 miles of track all through the city and suburbs, not a single man was present to offer an objection. The power at this time was furnished from the power house at Allston, and from the Cambridge Electric Light Company, but it was soon seen that this was insufficient, and the old Hinckley Locomotive Works, with their extensive grounds, extending from Harrison avenue to Albany street, were purchased with the view to building a large permanent station, another temporary station being installed meantime in the old foundry building, and equipped with MacIntosh & Seymour engines and Thomson-Houston generators, which have done yeoman service. On June 1st, 1889, Mr. F. S. Pearson entered the service of the West End Company, under whose immediate charge the whole work has gone on, and ground was eventually broken for the foundations of the central power station in August, 1889. Since then the capital of the company has been increased twice, the first time by $4,000,000, and the second time by $4,500,000.

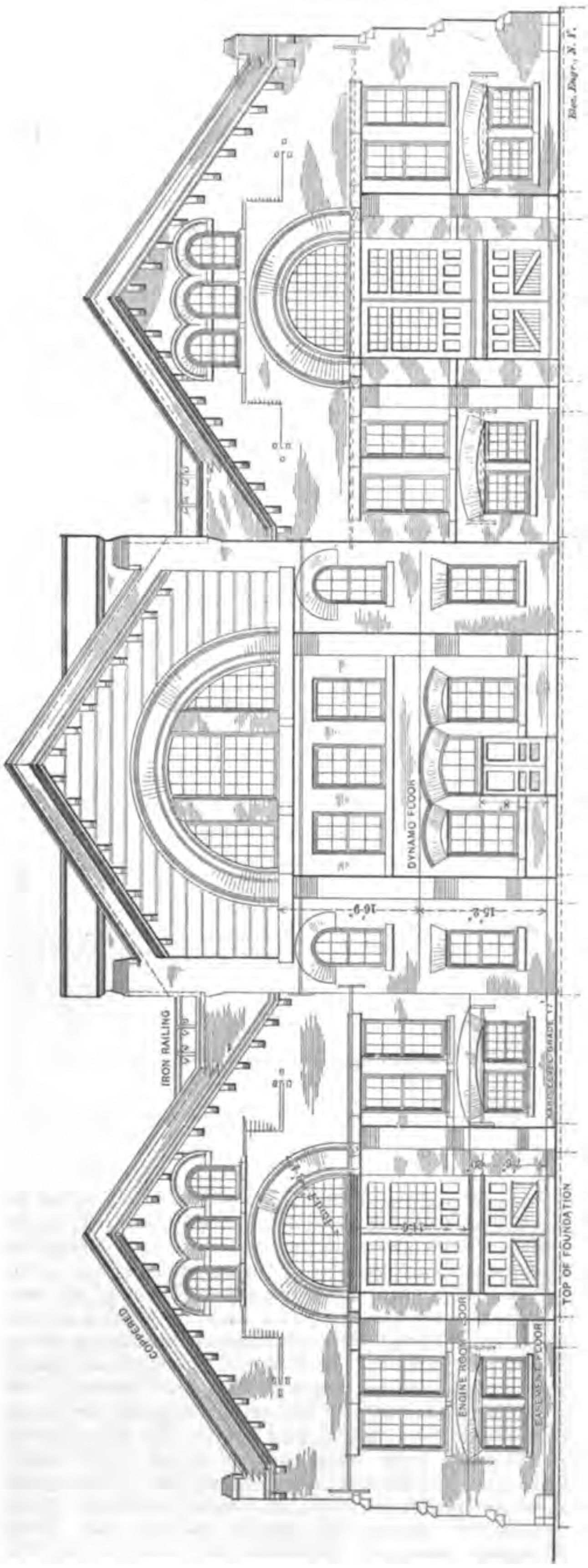


FIG. 2.—WEST FRONT OF THE POWER HOUSE.

III—THE BUILDINGS IN GENERAL.

The space secured in the lot, as shown in Fig. 1, measures about 830 feet long by 290 feet wide, extending from Harrison avenue to Albany street, and with a valuable wharf frontage of about 300 feet on the South Bay. This wharf will be equipped with a coal pocket, traveling cranes and all necessary appliances for the prompt unloading of coal, and it will be connected by a track with electric fittings to the boiler house. The station proper when complete will extend 510 feet from Harrison avenue, and will be 175 feet wide, excepting at the boiler house, where it is only about 86 feet wide. The plan of the ground shows distinctly its location, the dotted part showing the extension, with the temporary station occupying part of it; it shows also the machine shop and car shop, the carpenter shop, store house and offices. Taking the plan of building in detail, the boiler house occupies a space 161 feet long by 85 ft. 10 in. Adjacent to the boiler house is a space 30′ 4″, occupied by the economizers and smoke stack, feeder room, etc., and then comes the main engine and dynamo room, 147 feet long by 174 feet wide. The extension when completed will measure 172 feet long by the same width, making the total length of the station when finished 319 feet. On the site of the extension the old power house is situated, occupying 108 feet by 80 feet, and having 2,000 horse power capacity. This building will be torn down just as soon as the present half of the Main Building is all equipped and in running order. At present also one-half of the large boiler house is being used as a temporary station, being equipped with 2,500 horse power.

The fact that this immense station with its enormous weight of engines and machinery is situated on reclaimed land makes the foundation work of supreme importance and particularly interesting, and worthy of a few details of description. The surface of the ground is 17 feet above

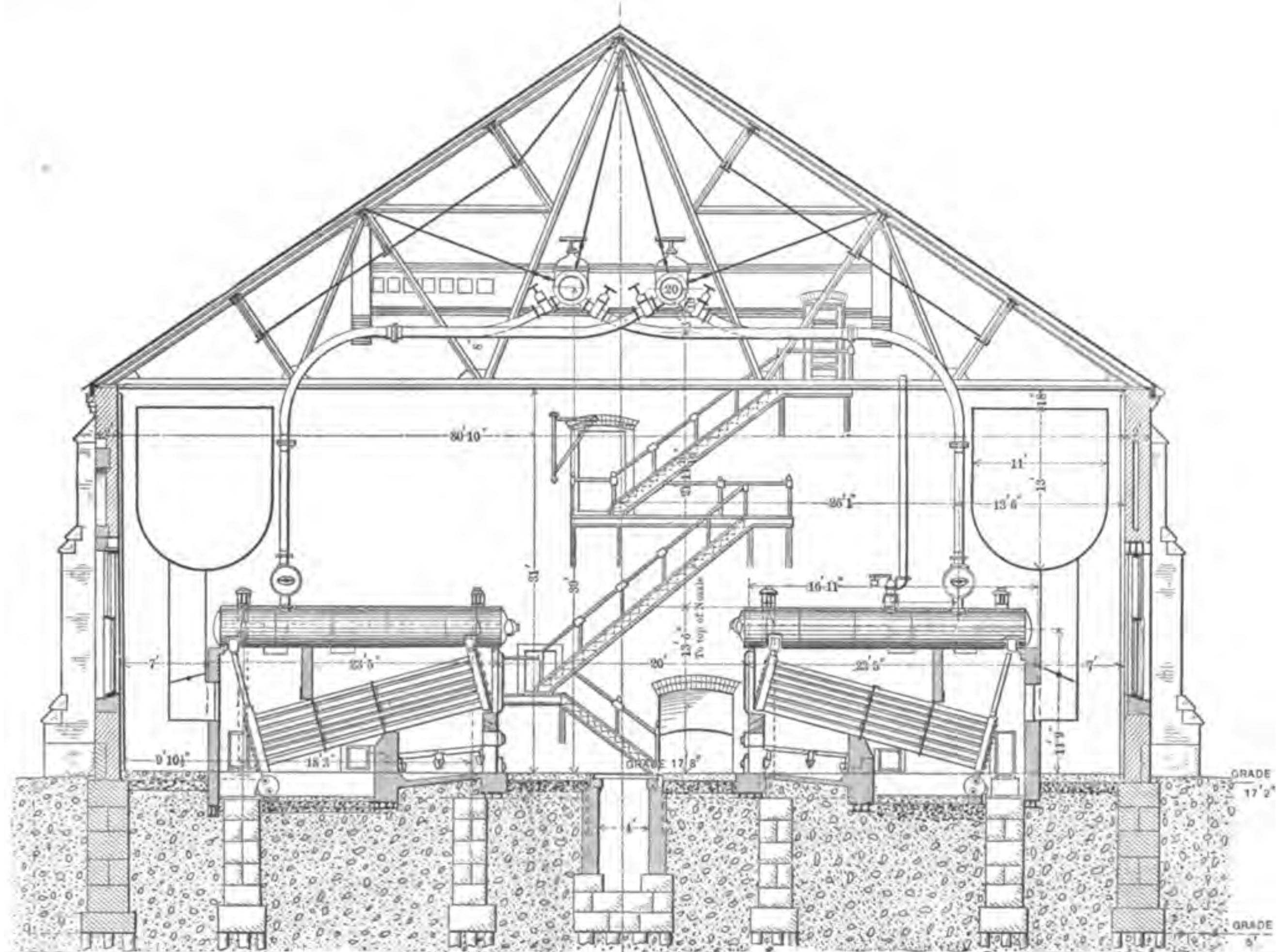


FIG. 3.—SECTIONAL VIEW OF BOILER HOUSE.

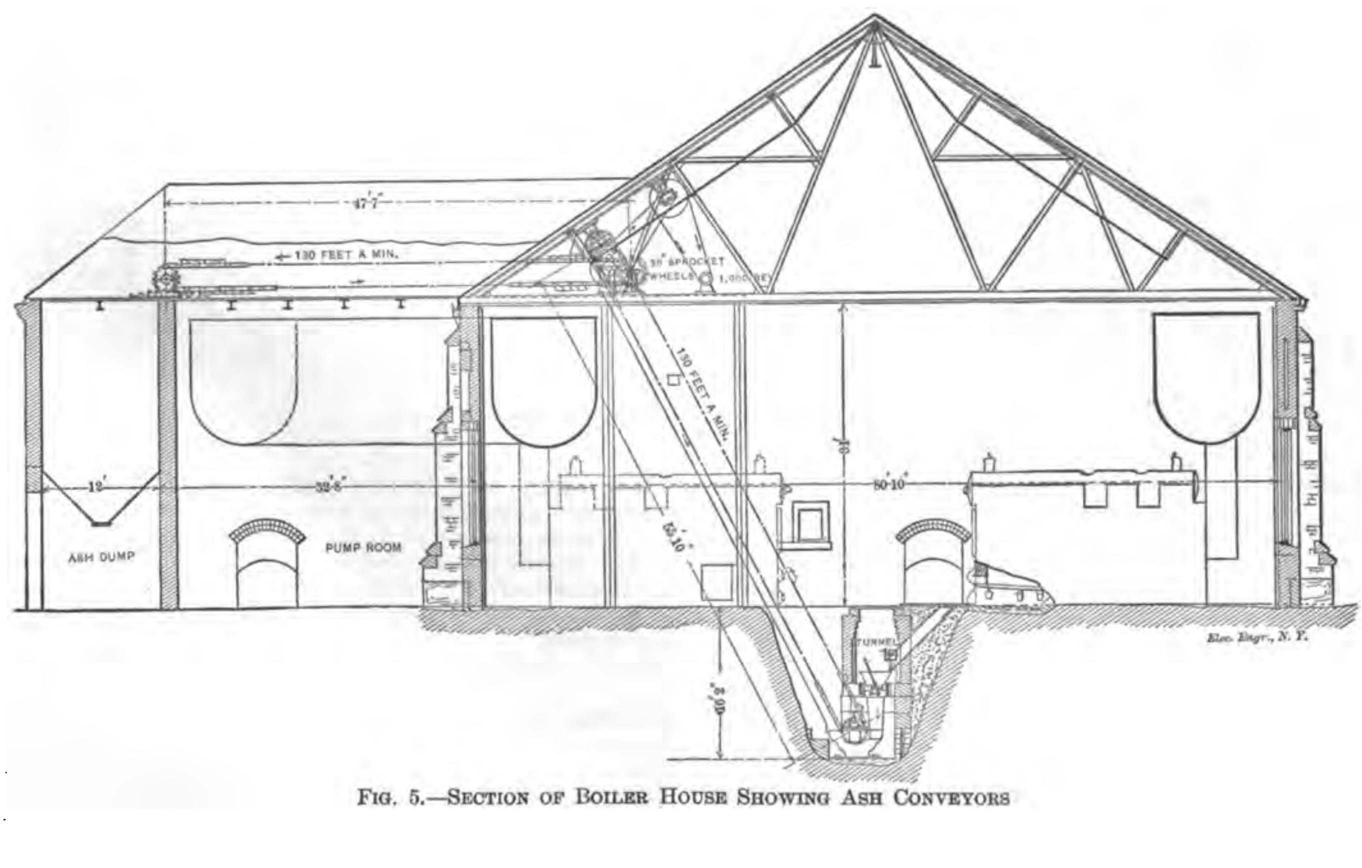


FIG. 5.—SECTION OF BOILER HOUSE SHOWING ASH CONVEYORS

mean low-tide water, and the whole space occupied by the buildings was excavated to a depth of just 17 feet, that is, to mean low-water mark. The whole square taken in by the engine room, the economizers and smokestack was then literally covered with piles 45 feet long and about 12 inches in diameter, they being driven at intervals of about 30 inches apart. Close piling is also underneath all the walls of the buildings. The piles in the engine room were cut off at 5 feet from low-water mark, while under the smoke-stack the piles were cut off just at low-water mark. Under the chimney alone there are 810 piles, and under the engines and machinery 6,000 piles have been driven. After the piles were driven, the whole excavation, extending across the engine and machinery room, was filled in with six feet of solid concrete, consisting of five parts of broken stone, two parts of sand and one of Portland cement, upon which the necessary masonry foundations rested. In the boiler house each battery of boilers is supported on six stone piers, each resting on five piles, but no concrete was used. It may be interesting to note that the total foundations, including the excavations, piling, concreting and masonry cost in the neighborhood of about $300,000.

The buildings are of brick, with brown stone trimmings, having slate roofs of graceful design, and well finished. The walls are about two feet thick throughout. The boiler house has a single-span roof, and the engine room a triple-span, the centre span being supported on latticed columns. The whole design, as shown in Fig. 2, is tasteful and compact, and the whole building presents a pleasing picture to the eye, and is well balanced in design.

IV.—THE BOILERS.

With this general description of the plan of the ground and the buildings, and their general design, it is now my purpose to describe more particularly each detail of the building, and naturally the boiler house, being the actual source of the power, attracts attention first. This is shown in section in Fig. 3, and in plan in Fig. 4. Entering this building the vastness of the work at once becomes apparent. On either side are arranged six batteries of boilers, manufactured by Babcox & Wilcox, of New York. These are the well-known water-tube type, and are of the latest pattern, each battery being capable of furnishing 2,000 horse power, making a total for the boiler room of 24,000 horse power. Only six batteries are used at present, enough for the first half of the station, which is now nearing completion. The shells are of steel and are designed to withstand a working pressure of about 200 pounds to the square inch.

Each battery consists of two distinct boilers, 23 ft. 5 in. long by 21 ft. 10. in wide, and about 15 ft. high, each boiler having three 36 inch horizontal drums, shown in Fig. 6, running length-wise of the boilers, made of steel and capable of withstanding a steam pressure of 200 pounds to the square inch. The boilers are all faced with white glazed bricks, specially imported, and present a very attractive and clean appear-

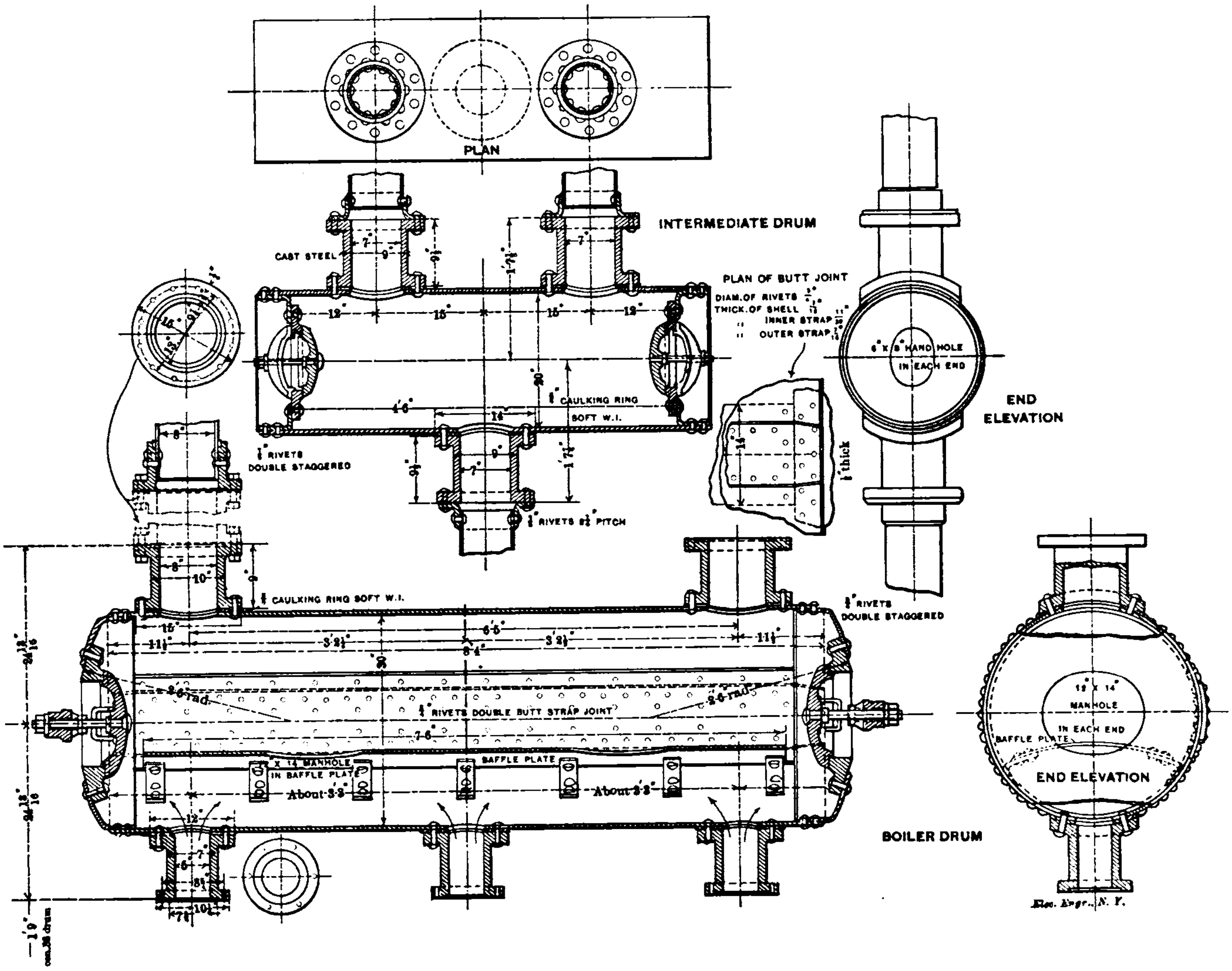


Fig. 6.—Drums for Steam Piping.

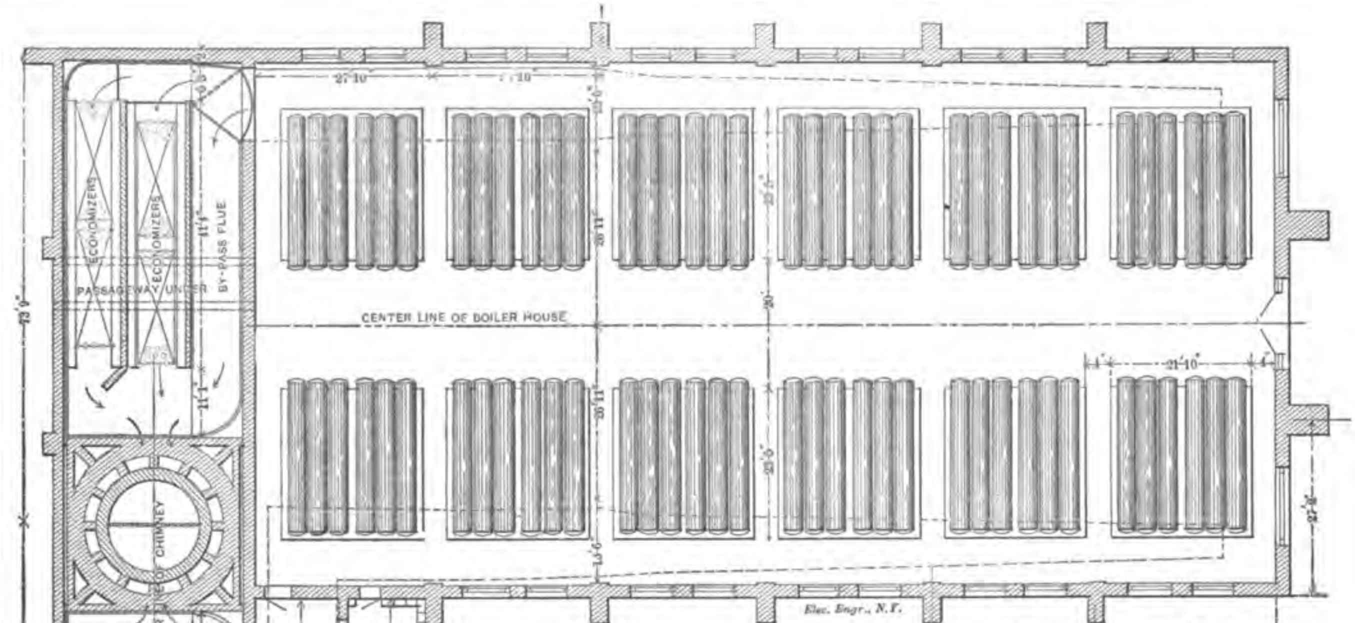
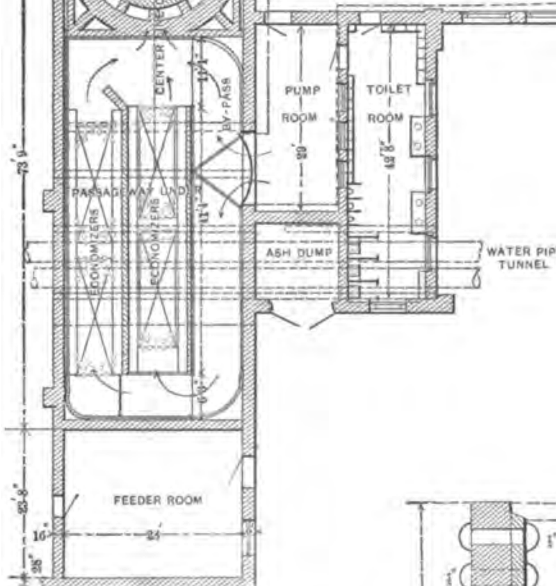



FIG. 4.—PLAN OF BOILER HOUSE AND ECONOMIZERS.

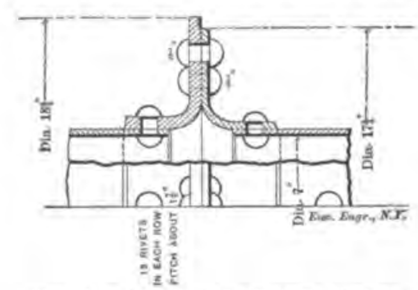
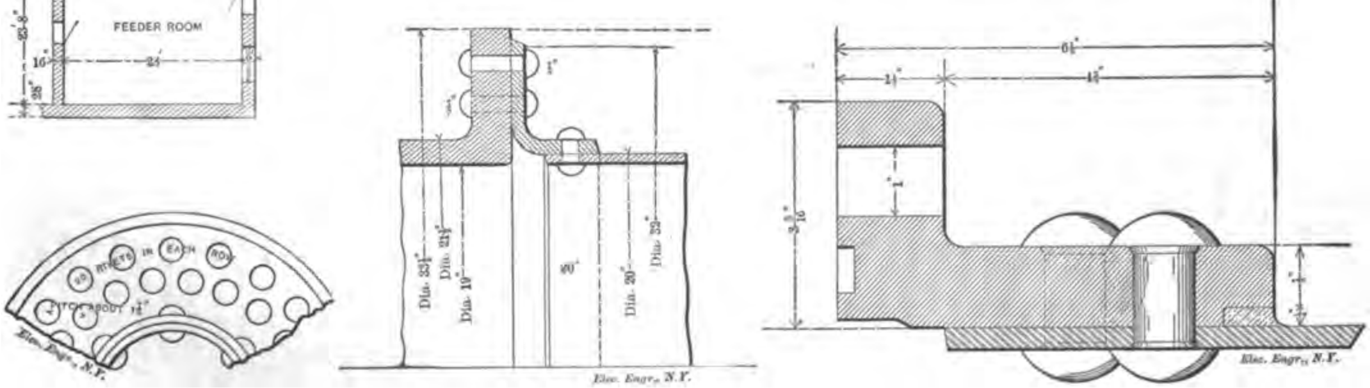


FIG. 9.—DETAIL OF FLANGE JOINTS.



FIGS. 8, 10 AND 11.—DETAILS OF FLANGE JOINTS.

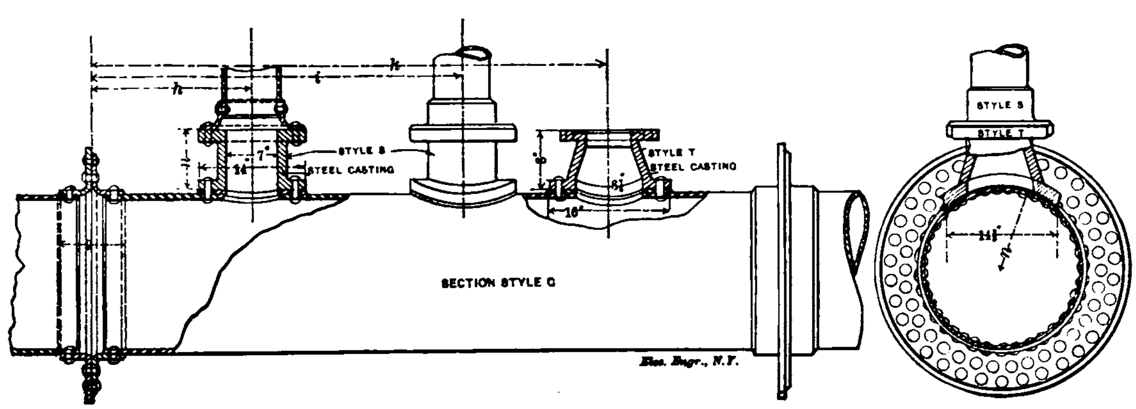
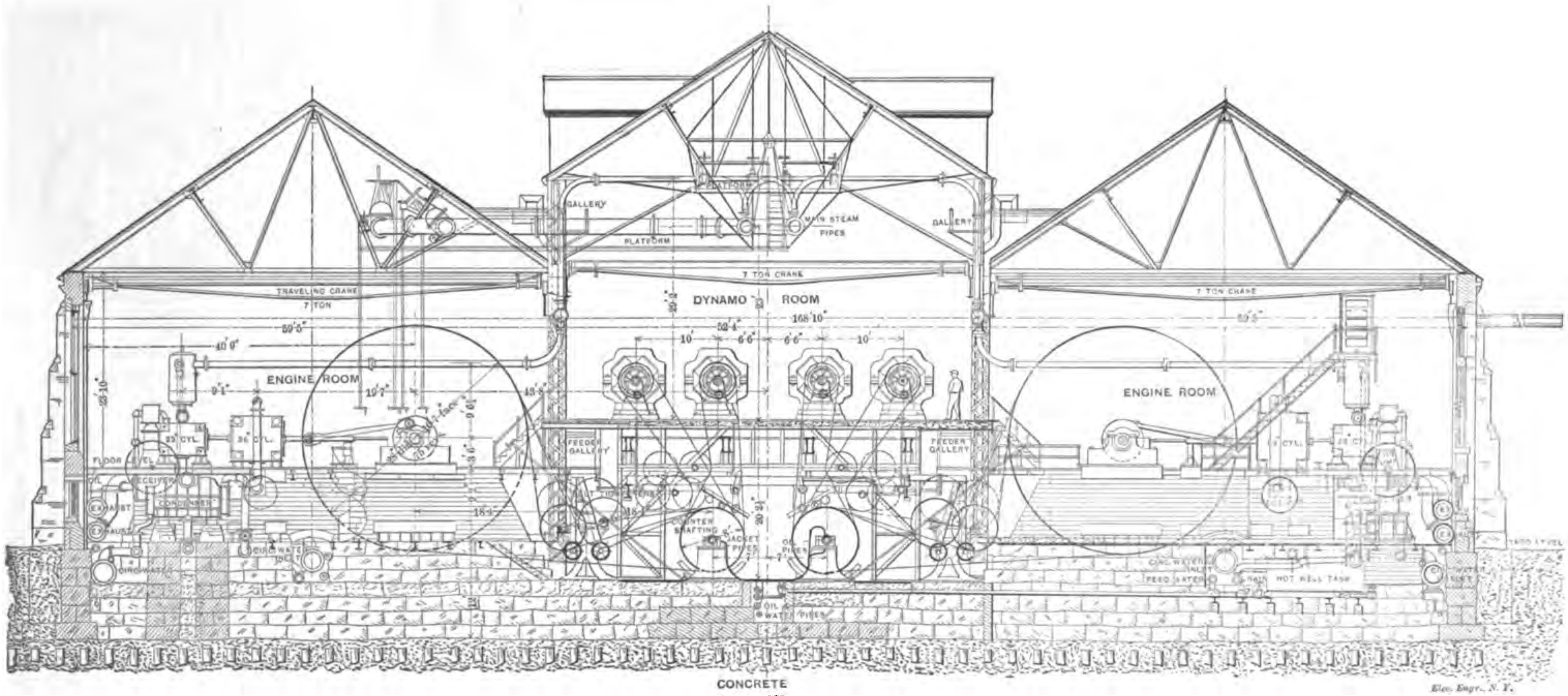


FIG. 7.—DETAILS OF STEAM PIPING.

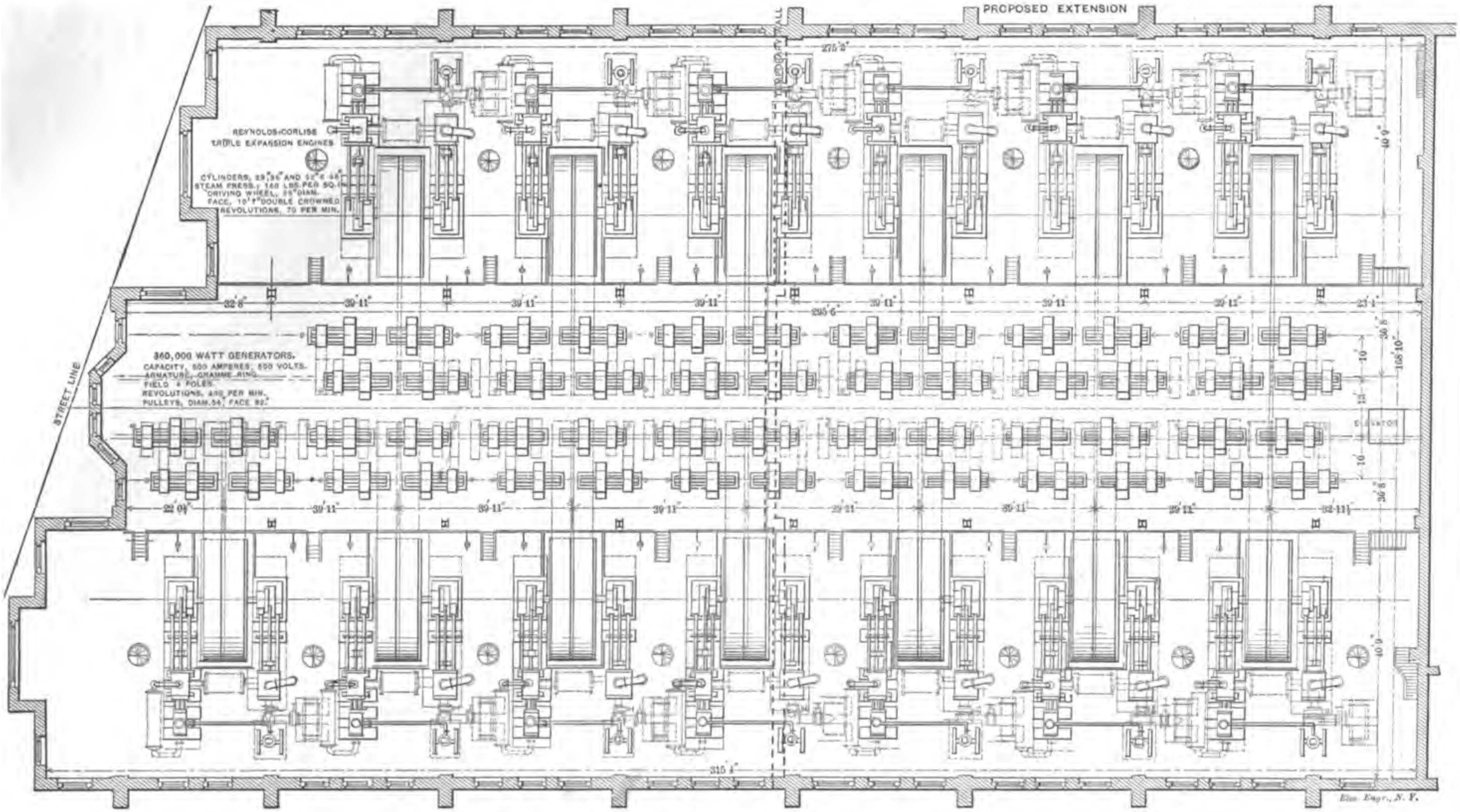


ance. A duplicate system of brass piping, tapering from 5 to 3 inches, runs along the walls of the boiler house with branches to each side of each battery, with valves, etc., complete, adding materially to the appearance of the boilers. The usual gauges, test cocks, etc., etc., are provided complete. Although only one side of the boiler house is at present equipped, the other side being used as a temporary station, one can get a very good idea of how the boiler house will look when completed. Between the two rows of boilers will be a space for firing and handling the coal, 20 feet wide, and in the centre of this space there will be a track for hand trucks for handling the coal. Underneath the centre of this space is located a very complete system of mechanism for handling and removing the ashes, as shown in Fig. 5. Opposite each fire door is a chute leading directly into this pit, through which the ashes are dumped into a series of hand cars and transported on rails to the

THE WEST END ELECTRIC RAILWAY, BOSTON, MASS.

Fig. 12.—Sectional View of Power House.

end of the pit at the end of the boiler house. Here the ashes are emptied into another recess, in which is constantly moving an endless chain gear attached to pan conveyors, which convey the ashes in an oblique direction to the top of the boiler house, whence another endless chain with pans conveys them in a horizontal direction to a large ash dump, whence they are hauled away at convenience by cartage. It is also intended to equip the boiler house with a complete system of automatic coal-handling apparatus. The smoke flues, supported from the roof truss, are shown at either side of the section of the boiler house behind the boilers, and are, at the end nearest the smokestack, 11 ft. wide by 13 ft. high, rounded on the bottom, and tapering down to about five feet by five feet at the further end. These flues will connect the boilers with the economizers, and will be covered by some insulating compound to prevent radiation of heat.



THE WEST END ELECTRIC RAILWAY, BOSTON, MASS.

FIG. 18.—PLAN OF POWER HOUSE.

The roofs of the boiler-house and dynamo and engine house, the general design of which has already been described and illustrated in a number of the accompanying engravings, have been built to meet the following requirements, and were built and erected by the Boston Bridge Works, of Boston.

The load provided for, in addition to the weight of all the material in the roof, is, first, a snow load of 20 pounds on every square foot of all the slopes and other surfaces, and at the same time provision has been made for a horizontal wind-storm of forty pounds blowing in either direction against every square foot. Provision has also been made to withstand the greatest stress possible from any combination of these loads. The strain allowed in the iron work nowhere exceeds 12,000 pounds per square inch in tension, and the strains in compression do not exceed 10,000 pounds per square inch, properly reduced in cases of posts, according to the most scientific formula for that kind of member.

The maximum strain on rivets is confined to 9,000 lbs. per square inch, and in rolled beams or channels the maximum strain allowed under the greatest load possible is 15,000 pounds per square inch. Bearing plates are provided under all the trusses, so that the pressure due to the greatest weight possible from the trusses on the masonry is not greater than 200 pounds on every square inch.

All material in these roofs is wrought iron, and it was tested during the process of construction of the work. All plates of iron were obliged to show in the tests a strength of 48,000 pounds for every square inch of area. All rolled forms of iron were obliged to show under test a tensile strength of 50,000 pounds per square inch. All plates and angles and other forms of iron were subjected to a test of sharply bending them to a right angle at a working heat without showing any sign of fracture. All rivets in the structure were subject to the test of bending double, either hot or cold, so that the sides came into close contact without showing any sign of fracture, and all iron was subject to the test of being bent cold 90 degrees around a small curve without showing any signs of fracture. All workmanship was subject to inspection, and conformed to the best practice and modern demands for high-class product.

V.—THE STEAM PIPING.

The steam-pipe arrangement and details possess a number of interesting specialties, which are shown in several of our figures. Steam is taken in the usual way from the drums of each boiler, and passes first into an auxiliary drum of 30 in. diameter, which connects all three drums of each boiler, and which is shown in Fig. 6. From each of these auxiliary drums two 8 in. pipes lead upward by means of a long graceful sweep to two 20 in. main steam pipes, leading into the power house. These main steam pipes are tapered down to 16 in. at the first battery, and are supported by a series of straps from the truss roof. The whole steam-pipe system is duplicate throughout, one system being capable of alone furnishing steam for the whole plant. The steam pipes are all wrought iron, lap welded, and the joints are all riveted throughout the entire station, the elbows also being made of wrought iron bent to the proper shape. The extreme high pressure of the

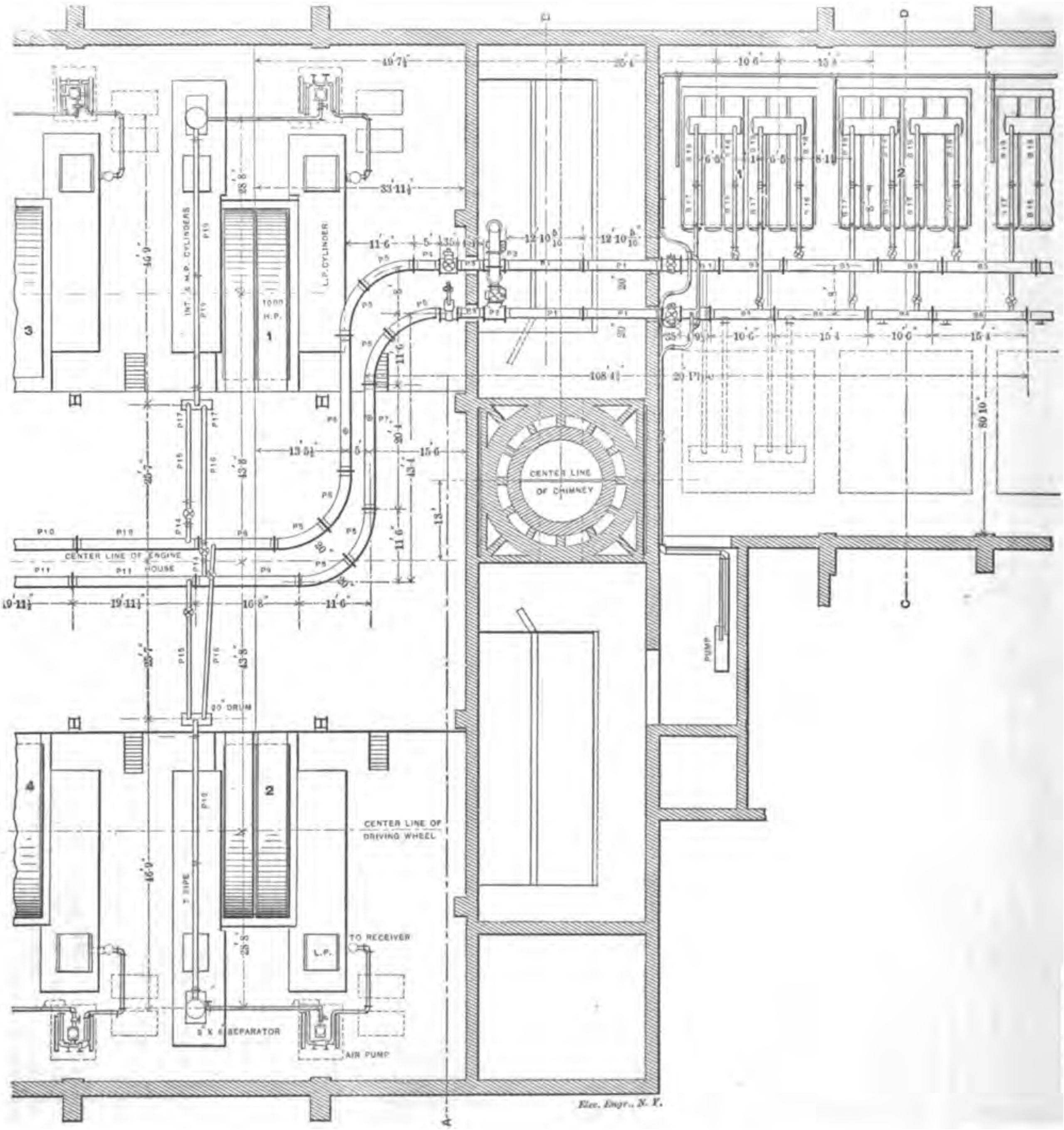


FIG. 15.—PLAN OF STEAM PIPING.

steam necessitates special care in the design of the joints. The joints are made with pressed steel flanges, single riveted to the pipe, and double riveted to each other, and are all caulked outside and inside, as shown in Figs. 7, 8, 9 and 10. All connection from the branch steam pipes to the main steam pipes are made with steel castings of a very heavy pattern, and the long sweep from the auxiliary drum to the mains allows for free expansion and contraction. These steel castings are riveted to the main pipes and have a soft iron caulking ring between them and the pipe, as shown in Figs. 7, 8 and 11. All joints at the valves are bolted

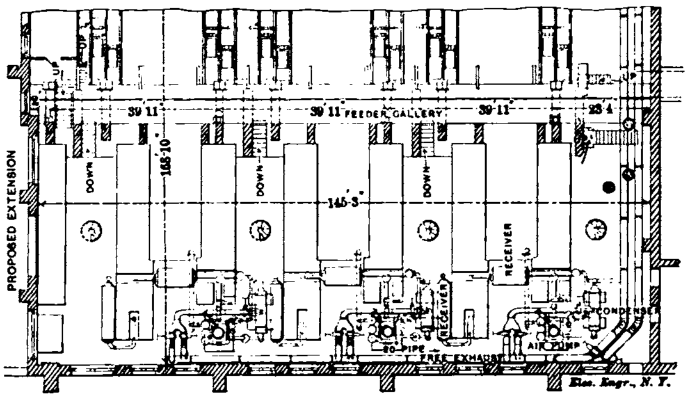


FIG. 13 A.—PLAN OF BASEMENT, SHOWING AIR PUMP, CONDENSERS, ETC.

and are made with tongue and groove, the groove being fitted with a packing ring. In each branch pipe is an automatic check valve of special design, and a Chapman gate valve, also of special design, being extra heavy and provided with a by-pass. Under the main pipe is suspended an iron gallery, to which access is had by a flight of iron steps at the end of the boiler house. The boiler-room roof is of iron, built by the Boston Bridge Works, as stated, and is a single-span truss roof, with two large cupola ventilators on the ridge, and three tastefully designed dormer windows on each side for light. The roof design is very solid and substantial, consisting first of 2 inch planking, then $\frac{7}{8}$ inch boarding, then $\frac{3}{4}$ inch of plaster, held in place by screeds, to which are fastened the slate. The under side of the planking is covered by wire, lath and plaster, so that the structure is thoroughly waterproof. The roof of the power house is of similar design, making the entire building unique in this respect.

VI.—THE ECONOMIZERS.

Following the path of the flues we come to the complete system of economizers, where the feed water for the boilers is heated by the waste gases from the boiler furnaces before passing up the smokestack. These economizers are of the Lowcock type, made in England, and consist of a series of vertical cast iron tubes 10 feet high and 4 inches in diameter. They are arranged in pairs, as shown in Fig. 4, each pair consisting of 600 tubes, 2,400 tubes in all, with connections top and bottom, through which the circulation of the feed water is maintained. The economizers are situated on each side of the smokestack, being situated in large brick chambers, occupying a space about 30 feet wide, 30 feet high by 174 feet long, including the chimney. The outer end of each chamber is open to the flues from the boilers, and the inner end open to the smokestack, so that the gases from the boilers must pass through these chambers before being allowed to escape. Each chamber is divided longitudinally into two by a brick wall, so that any economizer can be shut off by dampers, and repaired when necessary, and each chamber is also provided with a by-pass flue. The economizers themselves are situated on brick foundations, are 38 feet long by 7 feet wide, by 10 feet high, and each one of the 2,400 tubes is provided with a mechanical scraper which is kept constantly moving up and down the tube to prevent the collection of soot.

VII.—THE CHIMNEY.

Such a large steam plant requires a capacious smokestack, and a few details may be found interesting. Above the concrete foundation, already described, was built a granite foundation, seventeen feet in depth, 60 feet square at the base, tapering to 30 feet square at the top, solid throughout with the exception of three or four courses at the top, in which allowance was made for a soot chamber. The chimney is 28 feet square at the base, extending to a height of about 30 feet, the level of top of boiler house, from which point it is circular in section, 26 feet in diameter, tapering to 17 feet near the top, where it bulges out in a neat design to 22 feet in diameter at the extreme top. It is 252 feet high over all. The flue is 13 feet 8 inches in diameter, and is parallel all the way up, extending to within a few feet of the top. The chimney consists of an outer shell 32 inches thick at the bottom, tapering to 16 inches at the head, and has 12 internal buttresses extending the whole length, but not touching the inside core or shell, which is left free to expand by the heat of the gases. The inside shell is 21 inches thick at the base, and tapers to 8 inches at the top. The top of the chimney is provided with a tastefully designed cap of cast iron, made in 24 sections, and weighing 8,400 pounds. To this cap is attached a system of lightning rods, consisting of six 5 foot copper rods with spreading platinum tips, connected to each other by a copper ribbon, and to the water pipes in the ground by two copper ribbons cleated to the side of the chimney. Inside of the chimney and near the top is a means for taking the temperature of the escaping gases. This consists simply of an iron bracket and pulley with a wire rope, by means of which a thermometer can be raised to the top and the heat registered. It is worthy of note that the chimney was built entirely from the inside by means of an elevator.

VIII.—THE POWER HOUSE ARRANGEMENT.

Fig. 12 gives in general a section of the power house, showing the position of the engines, condensers, circulating pumps,

FIG. 14.—VIEW IN THE ENGINE ROOM.

counter-shafting, belt tighteners and generators, while Figs. 13 and 13 A show plans of the same building, giving the arrangement of engines and generators. The sectional view gives an excellent idea of the piling and concrete foundations already described, on which rest the masonry foundations for the engines and other purposes. Each engine requires two separate foundations, with a wheel pit between, each of which consists of a substructure of seven courses of granite, 12 feet high and about nine feet wide at the top. Upon this is built the superstructure of brick nine feet high and eight feet wide, into which are set the capstones on which the cylinders and engine beds rest. The air pumps and condensers have independent foundations of granite, as also the engine belt tighteners and two rows of counter-shafting. Looking at the plan as shown in Fig. 13 it will be seen that the station will consist of 13 units when complete, six of which are now being put in, the wall at the end furthest from the boiler house being temporary, as shown by dotted lines. It is the purpose of the West End Street Railway Company, as soon as the load can be withdrawn from the small temporary station, as shown in the plan of the lot already described, to tear it down and commence excavations for the extension. It may be said that the steam piping, circulating pipes, and exhaust pipes, etc., etc., are all made large enough for the capacity of the 13 units. Each of the above units consists of a Reynolds Corliss triple-expansion condensing engine, a Reynolds Corliss circulating vacuum and feed pump, Wheeler condenser, a forty foot section of counter-shafting and four electric generators, and the accompanying belts and belt tighteners. Each unit is therefore entirely independent of each other, and can be connected only through the shafting by means of clutches.

IX.—THE REYNOLDS CORLISS ENGINES.

The engines were built by Messrs. E. P. Allis & Co. of Milwaukee, Wis., and can develop 2,000 horsepower at their maximum, being made of massive proportions and very strong throughout. An excellent photographic view is shown herewith in Fig. 14 which is taken from the boiler house end, showing the vertical independent circulating and air pump in the foreground. The high pressure and intermediate cylinders are tandem, on one foundation, being twenty-three in. and thirty-six in. in diameter respectively, with a forty-eight in. stroke. The low-pressure cylinder is on the other foundation, and is fifty-two in. diameter by forty-eight in. stroke. The intermediate receivers, of which there are two for each engine, are placed between the cylinders just beneath the floor, and with the steam pipe connections are all covered with magnesia to retain the heat. The cylinders are all steam-jacketed and are also completely surrounded with magnesia. The fly-wheel is of mammoth design, being twenty-eight ft. in diameter, 10 ft. 7 in. face, and weighs eighty tons. It is double in its structure, being divided in the middle of its circumference, and built up of two rows of ten sections each, with two sets of ten arms of elliptical section, bolted to the rim of the fly-wheel at the intersections, and also bolted to the hub, which was cast independent of the arms. The flywheel is double-crowned, and carries two enormous double-ply leather belts, each fifty-four in. wide and 150 ft. long, to drive the counter-shafting in the basement, the belts being carried under the floor by means of a mammoth belt tightener, also situated in the basement.

Steam is supplied to these engines from the two mains, as shown in Fig. 15, as well as in Fig. 12, there being a connection to both mains, though only a single pipe comes to the engines, the two branches being connected by valves half way between the mains and the engines. This one steam pipe then enters a separator of special design, as shown, about thirty-six in. diameter by six ft. high, located over the throttle valve of the high-pressure cylinder. Similar connections are made to each engine. The main steam pipes, which are duplicate throughout, just as in the boiler house, are twenty in. diameter at end nearest the boilers, tapering to eighteen in. at the further end, and, as explained, have capacity enough for the complete station. Directly behind the low-pressure cylinder is situated the Corliss vertical circulating engine, also built by E. P. Allis & Co., which performs three distinct functions, namely, circulates the salt condensing water, operates the air pump for the condensers, and acts as a feed pump for the boilers. Each engine is provided with a Wheeler surface condenser, the cold water for which is provided by two lines of cast-iron pipes, drawing water from the South Bay. These pipes, which are entirely underground, start from the South Bay with a diameter of thirty-six in., one being the inlet and the other the outlet, and retain this diameter till they enter the basement of the power house, where each pipe branches into two, one for each side of the house, each branch being twenty-nine in. in diameter at the first engine, tapering to eleven in. at the furthest engine, with ten in. branches to each pump and condenser. These pipes are also designed large enough for the whole station, and will be sufficient to supply 20,000,000 gallons of condensing water per day. From the condenser the condensed or hot water is pumped into the hot well, which is situated in the wheel pit, and consists of a wrought-iron tank, there being one for each engine. From there it is pumped by a plunger on the same engine to the boilers, passing through the economizers, and being controlled by a complete set of valves in the pump room, described later on in this article. A duplicate system of piping twenty in. diameter has been erected, and shown in Fig. 12, next the walls of the building, to be used in cases of emergency as a free exhaust. These pipes having short rigid connections to the engines, are fitted with Wainwright patent corrugated expansion joints, manufactured by the Wainwright Manufacturing Company of Boston. No expense has thus been spared to make the steam part of the station absolutely reliable and capable of taking care of any possible emergency.

X.—THE COUNTERSHAFTING.

In such a station the counter-shafting is a most important factor, and much time was spent in elaborating the system now to be described, in order to get it compact and complete. One section of this shaft is shown in Fig. 16, and represents probably part of the largest counter-shaft for electrical purposes in the world. The design is unique and perfect, and embodies the latest improvements in the way of clutch connections and devices for disconnecting the power speedily and safely. It presents a solid and compact appearance, and is provided with all the latest appliances for reducing the amount of useless friction and wear and liability to accidents. Each section consists of a ten in. steel shaft, forty ft. long with four nine in. bearings. At the centre of the shaft, and supported on a steel quill or hollow sleeve, with independent bearings, is the main pulley eight ft. diameter by ten ft. seven in. face, cast in two circumferentially, and bolted together, and carrying the main driving belts, as described. This quill allows the shaft to pass freely through without touching the pulley, so that the shaft can move, if clutched to another engine, without moving the pulley, and allowing each engine to be started and stopped independently of the others. It also allows the weight of this large pulley with the heavy belt strain to be borne independent of the shaft, and when running, the strain on the shaft is taken outside and close to the bearings instead of between the bearings. To this sleeve is attached the clutch ring, as shown, and on the shaft adjoining the ring is keyed an eighty-four in. Hill friction clutch, specially designed for this purpose. Over the whole clutch there is a casing finished on the outside, so that there are no revolving arms or projections in view, and thus preventing much liability to accident. Each shaft is provided at one end with a clutch ring and at the other end with a clutch proper, so that it can be connected at any moment with the adjoining shafts. On either side of the main pulley are two dynamo pulleys, thirty-two in. face by eight ft. in diameter, driving the generators on the floor above by means of a thirty in. double-ply belt. All the boxes of the counter-shafting are jacketed for the purpose of having a cold-water circulation, to prevent any danger of becoming overheated. Each dynamo belt can be released from the driving pulley and

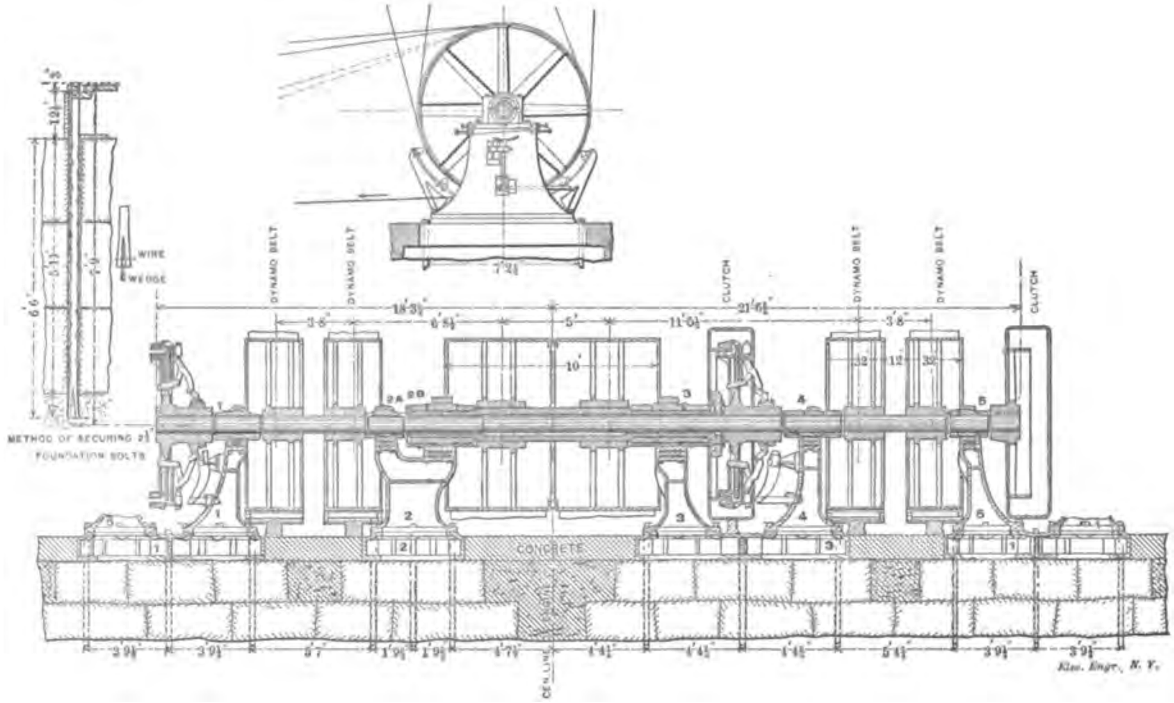


Fig. 16.—Shaft for 2,000 H. P. Engine.

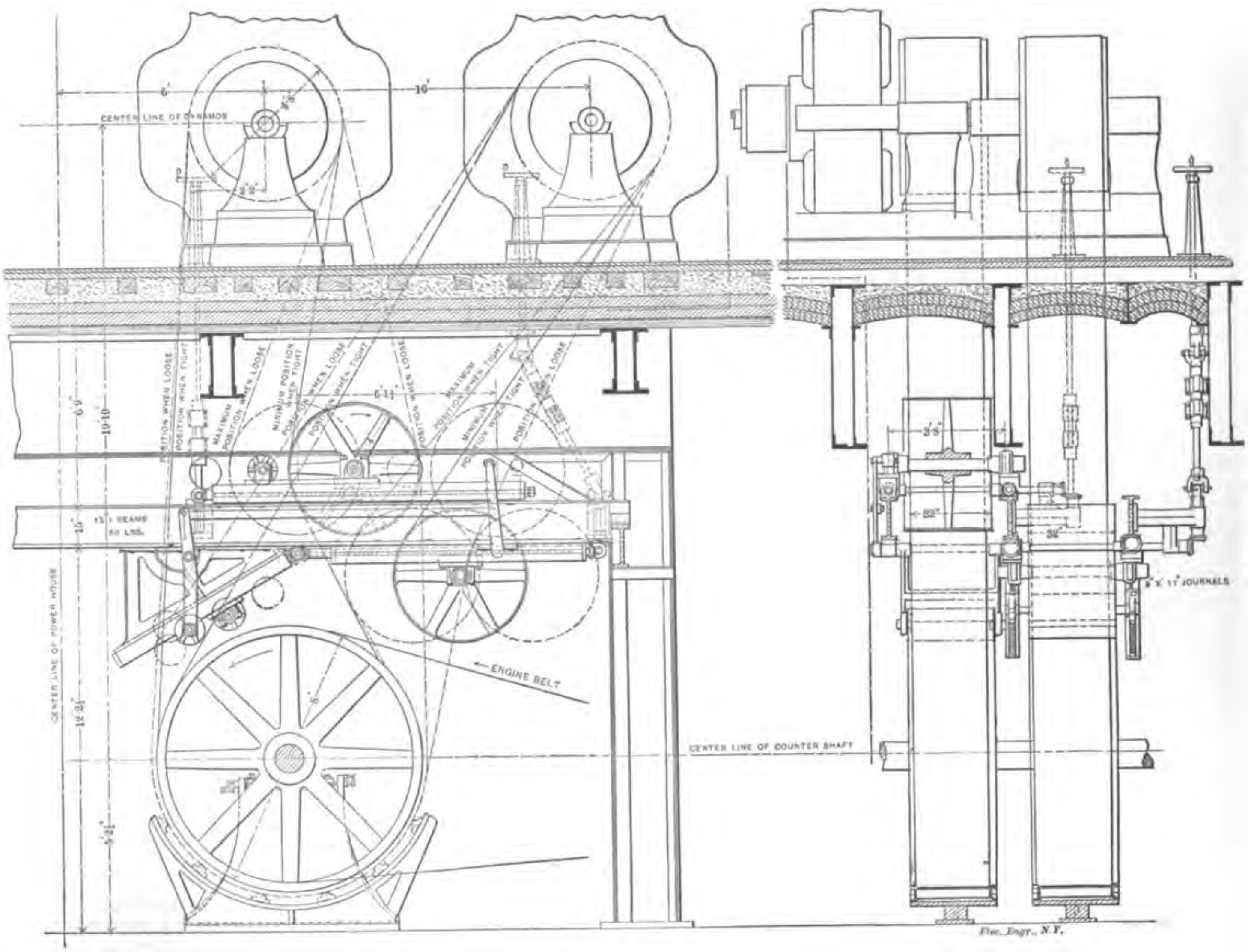
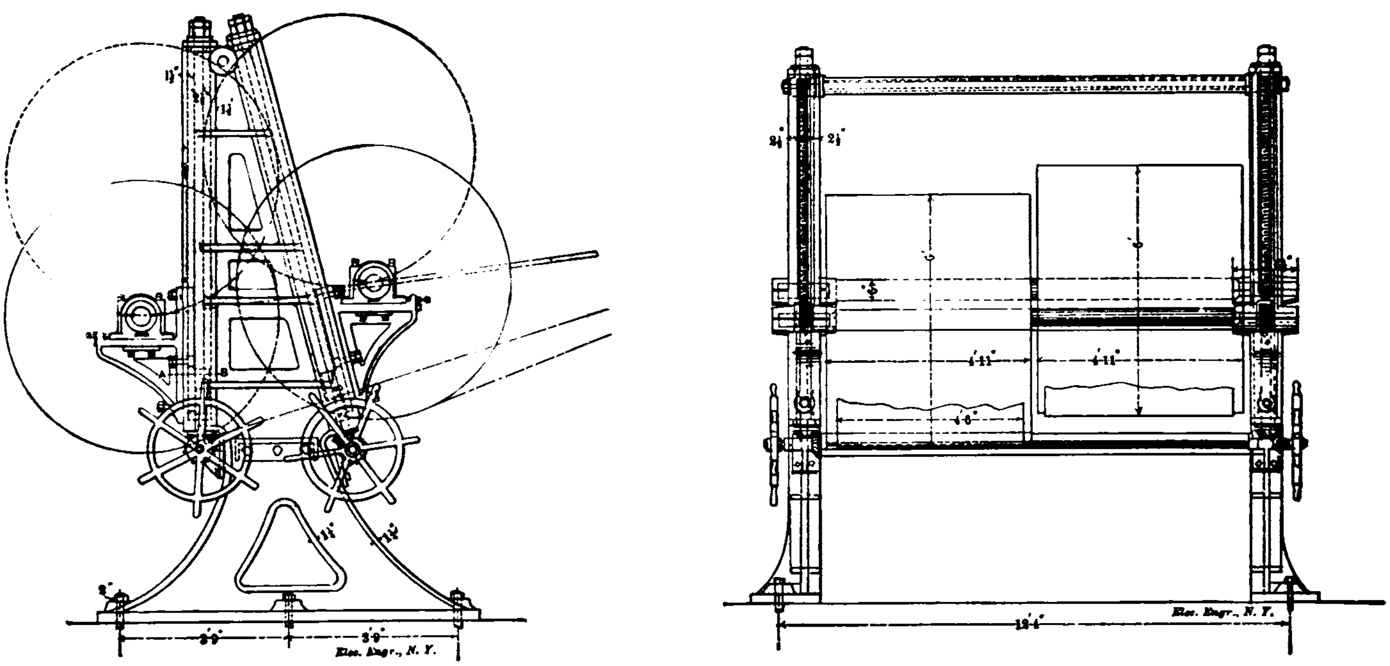


Fig. 17.—Dynamo Belt Tighteners.

supported on a cradle, shown in the figure and also in Fig. 17 carrying rollers beneath each pulley, so that any dynamo can be stopped while the engine is still running. The mechanism for releasing the belts is shown in Fig. 17, which shows the dynamo belt tighteners, and is operated by wheel-stands on the dynamo floor. The tightening pulley moves horizontally, and the frame is supported on horizontal beams. These pulleys are moved by means of a screw passing through the box on which the pulley is mounted, which screw is operated by bevel gears from the vertical shaft leading from the hand wheels on the dynamo floor above. The counter-shafting pulleys and belt-tighteners, including the main engine belt-tighteners, were all supplied by E. P. Allis & Co., while the clutches were manufactured by the Hill Clutch Works, of Cleveland, Ohio. The main engine belt-tighteners shown in Figs. 18 and 19 are the largest that have ever been built, and were specially designed. They are of massive design, and their location is shown in Fig. 12. Each belt tightener consists of a heavy upright cast iron frame, supporting two independent pulleys 6 feet in diameter and 5 feet face, which are situated on vertical sliding carriages, controlled by a heavy worm shaft operated in the basement by four 30 inch hand wheels.

and one span over the generator or dynamo room, supported on vertical latticed columns. Under each span is a seven-ton traveling crane, worked by hand power, for the convenient handling of any part of the machinery. These cranes, along with the whole roof construction, were supplied by the Boston Bridge Works. Under the middle span and suspended from it are the main steam pipes directly over the middle of the dynamo room and about six feet apart. Between these pipes and at a slightly lower level is an iron gallery which runs all the way through the dynamo room. At intervals opposite each engine, and above this gallery, are suspended elevated platforms, for the convenient handling of the branch steam pipe valves. Along either side of the dynamo room, above the ends of the traveling crane, are placed iron observation galleries, running the entire length of the building. All along the roof of the engine room have been placed skylights, and in addition there are a number of dormer windows, so that the dynamo room is thoroughly well provided with light. Under the floor of the dynamo room, at either side, is a feeder gallery four ft. wide by five ft. deep, for the accommodation of all the wires leading from the dynamos to the switch house, which has not yet been commenced.



FIGS. 18 AND 19.—ENGINE BELT TIGHTENER.

XI.—THE SELF-OILING SYSTEM.

Fig. 20 shows a very interesting detail of construction, consisting of a complete self-oiling system for all the machinery. Over the economizer room is loctated the distributing room for this device, containing receiving, mixing and service tanks and filters. The crude petroleum oil is received in tanks located in a basement just outside the boiler house, whence it is pumped into the distributing room, where it is refined and mixed for the various purposes for which it is to be used. In the engine house, at a very low point, are placed discharging tanks, into which the oil from the machinery after use is drained, and from which it is pumped back into the distributing room, carefully filtered, and used over again. There is a complete system of service pipes made of brass, and duplicate throughout, leading from the tanks to all parts of the machinery, and streams of oil can readily be procured at any point should any part become heated. The elevation of the tanks gives the necessary head to force the oil to any point.

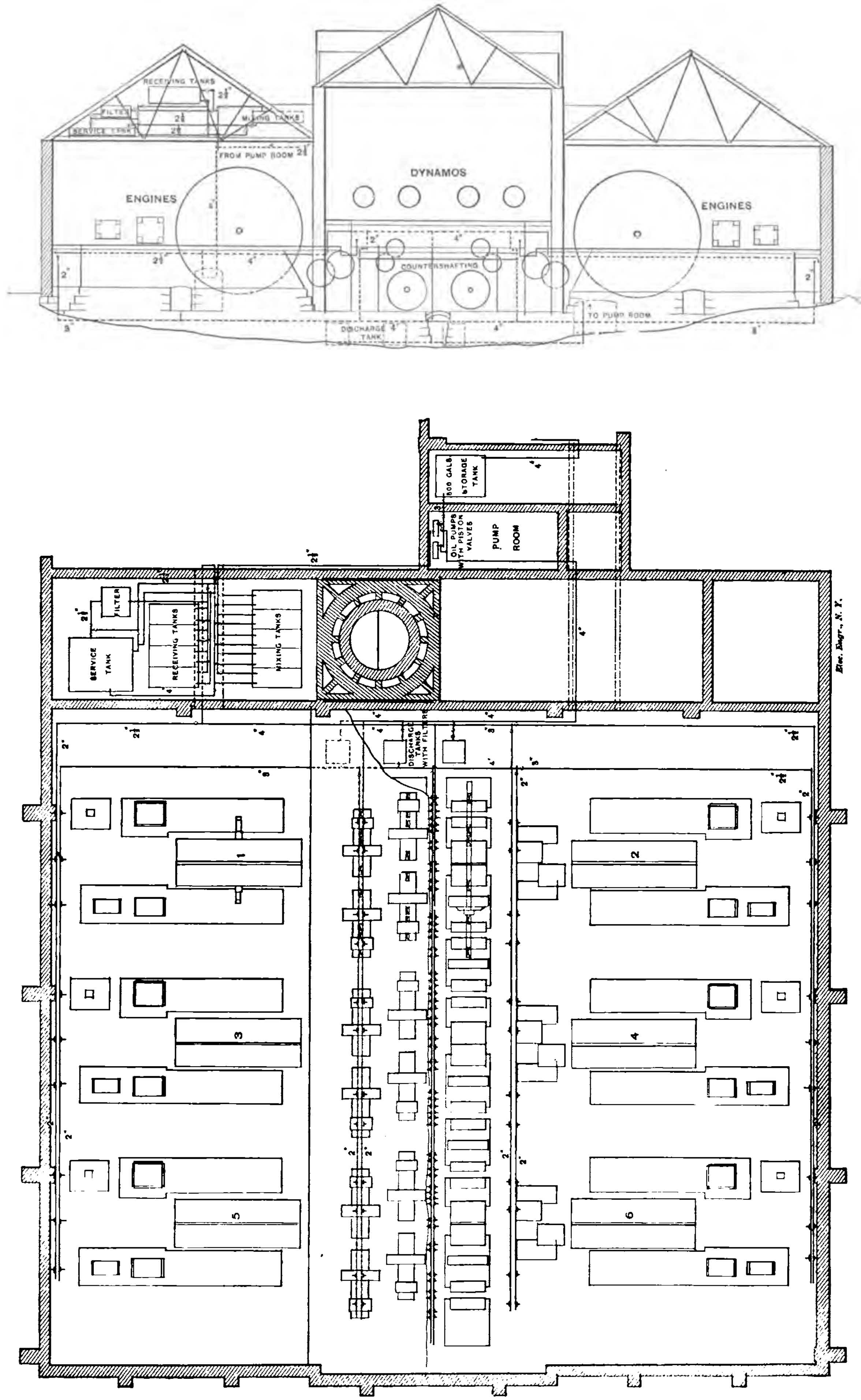
XII.—THE CRANES.

The roof of the power house is, as shown, a triple iron truss roof, one span being over each of the engine rooms,

XIII.—THE DYNAMO FLOOR.

The dynamo floor has been carefully designed, and is of unique structure, everything having been done to make it as solid as possible, and is supported on hollow iron girders and posts. These structures span the counter-shafting room, and are about seven feet apart, and rest upon the foundations already described. The posts are 6 ft. x 1 ft. cross section, and the horizontal girders 5 ft. deep by 10 inches wide. These form the tranverse girders and are all filled solid with concrete, being also braced with longitudinal girders 2 ft. by 18 inches cross section. Between the transverse girders and over the longitudinal girders were placed brick arches 8 inches in depth, the whole upper surface being then covered over with 18 in. of concrete, in which were embedded the spiking pieces for the finished flooring, which consisted of two inch planking and one inch hardwood boarding. So massive and solid is the whole structure that it is believed that there will be absolutely no vibration. The dynamo room floor measures at present 55 feet wide by 147 feet long, though when completed it will be considerably over 300 feet long.

The generators are arranged in four parallel rows running the whole length of the floor, four dynamos being



Elec. Engr., N. Y.

FIG. 20.—GENERAL SYSTEM OF OIL DISTRIBUTION.

driven from each engine. These generators will sit right on the floor, and are not intended to be moved from their position after alignment, the adjustment of the belts being made by the belt tighteners. They measure approximately nine feet high, eight feet wide, are 16 feet long and weigh each about 35 tons.

Figs. 12 and 13 show the general arrangement of the generators on the floor, and they are each driven by means of a 30 inch belt from the counter-shafting below. Fig. 21 shows the general design of the generator, which possesses apart from its electrical properties many interesting and novel mechanical features. It will be seen that each generator has four bearings, and that the pulley has a self-contained double jaw clutch, which adds materially to the flexibility of the whole system. The armature shaft is provided with two bearings, and is entirely independent of the pulley shaft, but extends into the pulley passing through the pulley quill without touching it, far enough to support a clutch ring, by which the power is communicated to the armature. The pulley is 56 inches in diameter and 32 inch face, and is split on the circumference and bolted together, each half being supported on a separate quill, having one bearing each. The outer quill carries the clutch mechanism of special design with levers extending outside to a controlling hand wheel, as shown.

inches in diameter and 25 inches long, and is wound in 180 sections; the conductors of which have a capacity of 800 square mils per ampere at 600 amperes; consequently a load of 1,000 amperes could safely be carried in case of an emergency. It is mounted on a shaft 7 inches in diameter, and with the commutator weighs about 9 tons. The armature core is built up of the best quality of sheet iron 46 inches in diameter, each sheet being punched in two sections, the joints of the one layer being so arranged that they do not come opposite the joints of the next layer. The depth of the ring is about 8 inches, and the whole core is carried on two spiders of gun metal, each spider having six arms which are carefully forced on to the shaft by immense pressure and then keyed. The insulation of the armature from the core has received special attention, and is made to withstand a test of 3,000 volts alternating. The commutator is 24⅝ inches in diameter, with a brush surface of 15 inches, and when completed will weigh about 1,900 pounds. The sections, of which there are 180, are made of hard drawn copper, separated by the usual mica insulation, the copper bars having a depth of about 3 inches. These bars alone weigh in the neighborhood of about 1,000 pounds. The shell on which the commutator is built and the caps which hold the sections in position, are made of gun metal. The manner

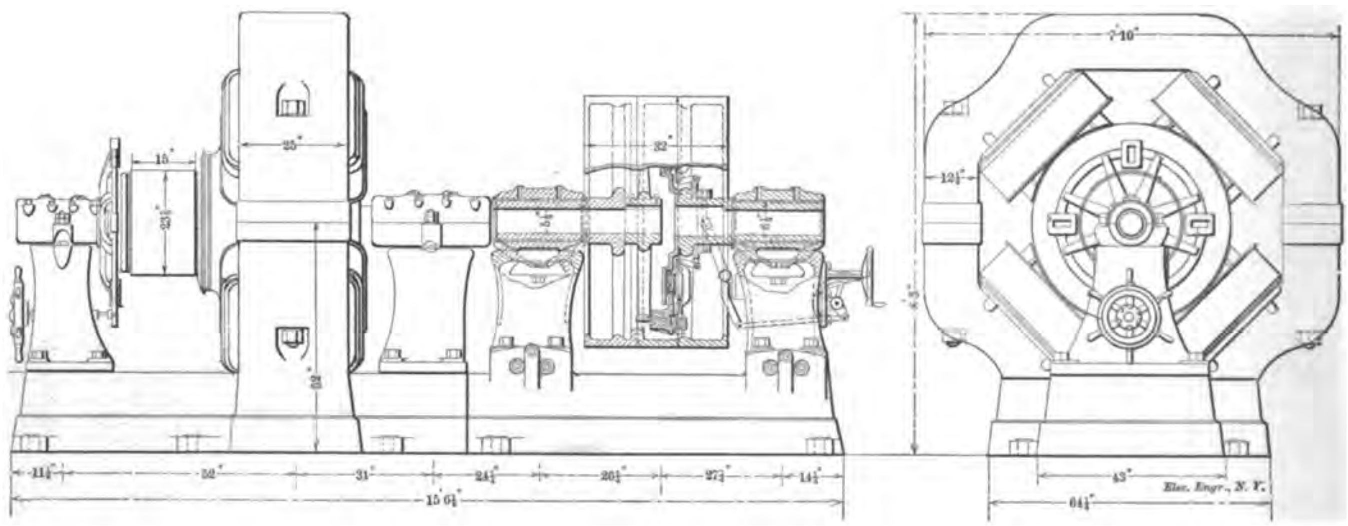


FIG. 21.—THOMSON-HOUSTON MULTIPOLAR DYNAMO IN WEST END STATION.

The pulley of the generator can thus be run independently of the armature, and the generator cannot be started up, even though the engine and counter-shafting are running, without throwing in gear this clutch. It will thus be seen that a perfect control of each and every generator is attained, and any generator can instantaneously be stopped from the generator floor without waiting for engine or counter-shaft or generator pulley to stop. The stands which support the pulley-shaft bearings have a wedge adjustment for purposes of alignment, and all four boxes are also capable of adjustment, being of the ball-and-socket pattern.

XIV.—THE GENERATORS.

HAVING thus described the general mechanical construction of the generator, a few words regarding its electrical construction will be found interesting. The generator is of the Thomson-Houston multipolar type, known as the M. P. 360, having 4 poles, with a maximum capacity of 600 amperes at 600 volts, or equal to 360,000 watts when running at its normal speed of 400 revolutions per minute. Each generator, therefore, reckoned in mechanical units, is capable of giving out about 500 h. p., four of them being therefore a full load for each of the 2,000 h. p. engines. The armature is of the Gramme type, about 48

of connecting the conductors of the armature to the commutator is precisely the same as in other Thomson-Houston generators. In order to meet all the varying conditions of load, specially incidental to electric railway work, each generator has been made with compound winding, the series winding being so arranged that the amount of over compounding can be varied to give different arrangements of compounding for various loads. The field winding is on spools, easily removable, as is usual in this type of machine, built up of special insulation, the field magnets having to stand the same crucial test as the armature. Each generator is built to stand a continuous run of 24 hours with the maximum load, the temperature at the end of the run to be within specified limits. The current is to be taken from the commutator by four sets of carbon brushes, each set consisting of five double carbons. The yoke carrying the brushes is arranged so that they can be moved by means of a spur wheel and gear, as shown in the figure. These generators are not as yet completed, but are well forward in course of construction. The station at present is being equipped with "M. P. 80" generators, each having a capacity of 80,000 watts, 12 of these generators being driven by each engine. As there are only four driving pulleys on each section of counter-shaft, two of these generators have been connected end to end through a common pulley. This pulley is made in halves, one-half being keyed to the shaft of each generator, and the two halves then bolted together, being driven by one belt.

XV.—THE VALVE ROOM.

A station of the magnitude of the central power house, requires an immense amount of piping for feed-water purposes, and it is just as necessary to have a central distribut-

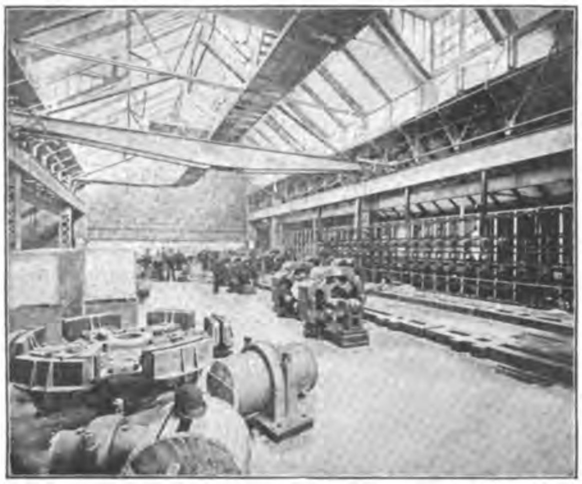


FIG. 23.—VIEW IN THE DYNAMO ROOM.

ing room for this purpose as it is to have a switch room for the distribution of the electric circuits. Accordingly a pump room, or really a valve room, has been provided for this purpose, not shown in any drawing, as it is impossible to distinctly show it to such a small scale as could be used, from which room the whole system of pumping is controlled. To this room, which is situated in the angle between the power-house and the boiler-house, lead all the feed-water pipes from the boilers, pumps, economizers, city water pipes, and also pipes from the salt, circulating water supply. Thus, any combination of effects can be produced, and water of almost any description sent to the boilers. Ordinarily the feed-water is pumped by the circulating pump direct from the hot well to this room, whence it is sent to the economizers, and then again returns to the room, and is then distributed to the boilers. Valves are so arranged, however, that the water from the hot well can be sent direct to the boilers without passing through the economizers. City water can also be used, and by a combination of valves, can be sent either to the hot well or direct to the boilers, or through the economizers to the boilers. Salt water can also be utilized in the same way in cases of extreme emergency. An auxiliary pump is also situated in this room, together with Hancock inspirators, for feeding the boilers in case of emergency, and for distributing water through the building in case of fire. In this way any possible chance of dearth of feed water is entirely overcome, and every possible emergency fairly met. Special meters and a full testing equipment are also provided in this room for carefully measuring, when testing, every pound of water fed to the boilers. Valves are also provided for this purpose, so that the water in passing through the testing instruments can be fed to the boilers in the various ways described.

All the hot-water piping in this room is of brass, as it is throughout the station, and some idea of the completeness of this system may be given when it is stated that there are over 100 Chapman valves in the room of various sizes.

XVI.—A WORD ABOUT THE BELTS.

In describing the engines, the counter-shafting and the generators mention has several times been made of the belts, but these are of such exceptionally large dimensions, and involve such an enormous amount of belting, that a few further particulars will be found quite interesting. Much attention has already been attracted by these belts, owing to their magnitude, and the important part they play in the transmission of the power. Our cut, Fig. 22, represents the belting used for the first three of the large engines and their accompanying generators, as packed ready for delivery. The belting was all built by Mr. Charles L. Ireson, of 97 High street, Boston, who now has the honor of having made the largest amount of leather belting in one order ever given out in this country. The large belts are each 54 inches wide and about 150 feet long, there being two of these belts to each engine, making a total of 1,800 feet of 54-inch belting for the present capacity of the station. Their approximate breaking strain is 64,800 pounds. They are made exclusively from the centres of extra heavy hides of pure oak-tanned leather, carefully selected and double throughout. On the side next the pulley it is made of two 27-inch widths, and on the outside there is one 20-inch width in the middle and a 17-inch width on each side. The centre of five hides is thus required for one width of belt, and it took 165 hides for each belt, or 1,980 hides for the twelve belts, weighing 79,200 pounds of leather. Two belts being used on each pulley, the width of belt surface on the pulley is therefore 108 inches, supposed to be the largest belt surface ever used on a single fly-wheel, and is wider by 34 inches than anything known in this country. The belts for the generators, numbering 24, are 30 inches in width, and are made of the same high quality of stock. These will consume 625 hides, or 27,000 pounds of leather, making a grand total for the six engines and 24 generators of 2,600 hides,

FIG. 22.—IRESON BELTING FOR THE WEST END RAILWAY CO.

or 104,200 pounds of leather. Each pair of the large belts will transmit 2,000 horse-power at a speed of 6,000 feet per minute. All the belts are endless, made of very carefully-selected stock and of the heaviest leather, and are cemented only, there being neither pegs nor rivets nor sewing.

XVII.—HANDLING THE CURRENT.

Though the electric equipment of the station is not yet very far advanced, it is interesting to note the arrangements that will be made for handling so great a volume of current with safety and precision. Adjoining the economizers already described, will be situated two rooms, the switch or controlling-room on top, and, directly underneath, the feeder-room. These rooms are both the same size, 26 x 28 feet. The wires from the generators will be carried in the feeder galleries, already mentioned, and brought up through the feeder-room on the walls (the floors of this room and the switch-room being a few inches away from the walls) up to the switch-room. In this room, ranged all around the four walls, will be the governing instruments for controlling and regulating the generators. These will comprise voltmeters, ammeters or current indicators, automatic circuit-breakers, polarity indicators, lightning arresters and make and break switches. These instruments are all of special design and are being made specially for this work, many of them embodying entirely new principles, and everything will be done to have this room as complete as the present state of the art admits.

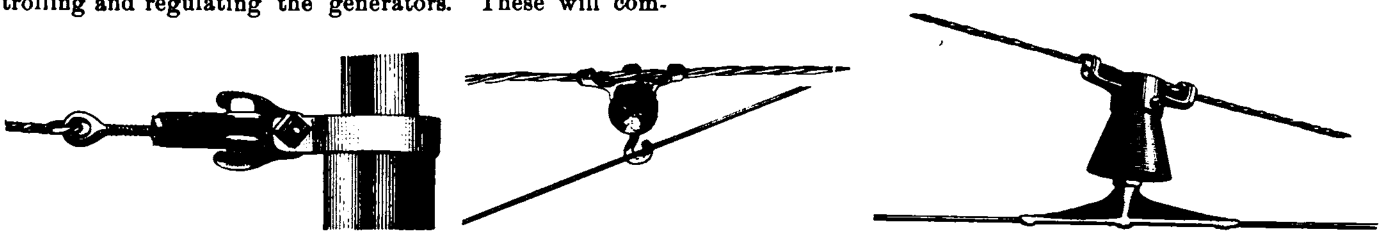
The control of the generators will thus be entirely away from the generator-room, similar in many respects to the controlling-room in large railway depots.

From this room the wires will all pass down again to the feeder-room, where they are all subdivided into the different feeder circuits, each feeder being provided with a switch, current indicator and lightning arrester. From here it is the intention of the company to run the feeders into underground conduits, which will reach to various centres all over the city. At present the feeders are carried on poles. As shown in our photographic view of the dynamo-room, Fig. 23, there has been erected a temporary switchboard, 50 feet long by 12 feet high, merely for the control of the generators now being used, the main bus wires of this board being connected with the main bus wires in the adjoining temporary station, and distributed from two feeder boards in that station to the various feeders already existing. It is worthy of notice that all the inside wiring above described has been done with Okonite wire furnished by the Pettingell-Andrews Company, of Boston.

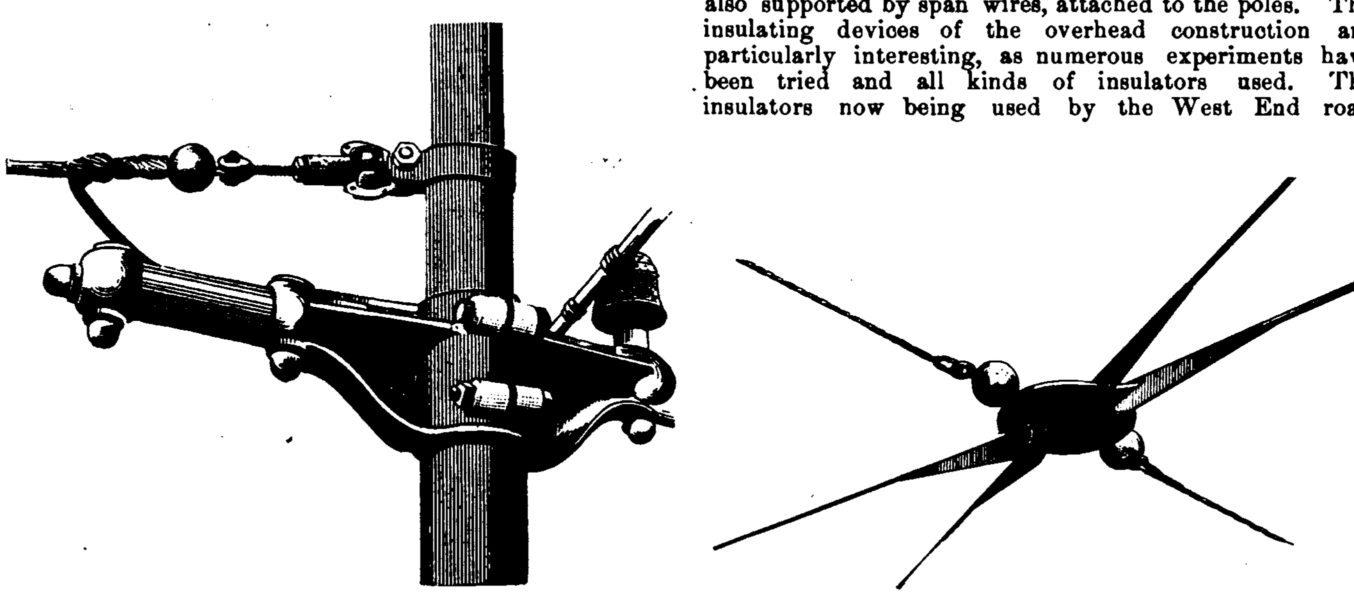
XVIII.—DETAILS OF LINE CONSTRUCTION.

While not strictly within the province of this article, the outside construction for the complete equipment of an electric railway system forms so important a feature that it is expedient to give some idea of the details, together with a few particulars of the track and the cars. At present there are about thirty-five feeders, varying in size from 200,000 to 500,000 circular mils, and amounting in all to about 180 miles of circuit. Some of these feeders run without being tapped direct to centres of distribution, frequently located in the car stations, from which the sub-feeders can be controlled. Other feeders are tapped all the way along, making connection with the trolley wire at frequent intervals.

The poles for supporting the span wires and also the feeders are all of the Walworth type, manufactured by the Walworth Manufacturing Company, of Boston. These poles support the span wire, consisting of three No. 9 twisted iron wires, insulated from the pole and insulated from the trolley wire, which is of No. 1 B & S hard drawn copper, over which are stretched iron guard wires, also supported by span wires, attached to the poles. The insulating devices of the overhead construction are particularly interesting, as numerous experiments have been tried and all kinds of insulators used. The insulators now being used by the West End road almost exclusively are made of moulded mica, manufactured by the Gould and Watson Company, of Boston, who were the first to develop the field of combining metal with insulation for such devices. A few of the most important devices are shown in the accompanying cuts, taken from actual photographs of the construction on the road, and for which I am indebted to Mr. Lee, of The Gould and Watson Company. Fig. 24 represents the Brooklyn strain insulator in position for insulating the span wire, and at the same time for tightening it up easily without much manipulation. Fig. 25 shows a similar device where the



FIGS. 24, 26 AND 27.—DETAILS OF WEST END LINE CONSTRUCTION



FIGS 25 AND 28.—DETAILS OF WEST END LINE CONSTRUCTION.

side feeder itself acts as the span wire, requiring the insertion of the extra Globe insulator for double insulation. This cut also shows a Walworth bracket for carrying the feeder, to which the side feeder is attached. Fig. 26 shows the regular and latest type of trolley insulator, with a metal sheathing or covering, enabling the insulation to be totally independent of the weather. Fig. 27 shows a guard wire insulator, an extra precaution in case of electric light or other wires falling on them. These spherical insulators consist of brass rings strung through one another, being cast in this way and surrounded with, and separated by, insulation. These globes are also occasionally inserted in the guard wires, so that should any portion of a guard wire come in contact with a line wire, the current cannot travel very far. Fig. 28 shows a switch suspended by insulating globes, the switch being in contact with the trolley wire.

A view of the general construction of the overhead system is given in Fig. 29, showing Tremont street, looking from the Park Street Church. The Ætna insulators, 35 feet over all, and all the new cars are long ones. These long cars may be divided into two distinct types, the eight-wheel cars and the six-wheel Robinson radial cars. The eight-wheel cars, of the most recent type, are the design of Mr. Louis Pfingst, master mechanic of the road, and the trucks are built by the well-known Bemis Car Box Company, of Springfield, Mass., and embody all the latest improvments. One or two other trucks are also used, one being made by the Tripp Manufacturing Company, of Boston, and one by the Taunton Locomotive Works, of Taunton, Mass. These cars measure 25 feet long over the body, and 35 feet over the dashboards; are 7 ft. 6 in. wide, with a height of 8 ft. 6 in inside, and have a comfortable seating capacity for 34. The interior of the cars is finished in cherry, with three-ply oak-veneered ceilings, stained antique. Bronze trimmings are used throughout, handsomely polished and lacquered, and in addition to single lights distributed through the car, have a Smith combination electric and kerosene lamp in the centre. The trucks

FIG. 29.—OVERHEAD CONSTRUCTION ON TREMONT STREET.

manufactured by A. & J. M. Anderson, of Boston, are also used by the West End road, and have given good satisfaction.

The track construction has been made very solid, and is designed for smooth riding and good wearing qualities. The rails are all of the girder type, set on chairs or stringers, and weigh 75 pounds to the yard, and there are at present over 100 miles of double track equipped electrically. Between each track in the earth is a No. 1 B & S soft-tinned bare copper wire, connected to each rail on either side by a No. 4 B & S copper wire, soldered to the main wire and riveted to the rail. Where the traffic is very heavy there are three No. 1 wires between each track, the ground return not being depended upon to any extent.

XIX.—THE CARS ON THE ROAD.

At present there are 300 electric cars actually equipped, and there are 250 in course of construction, all of which will doubtless be in service within the next few months. The ordinary short 16-foot cars are rapidly being replaced, probably more than half of the present equipment being long cars, averaging 25 feet inside measurement, and of the Bemis swivel type have 14 ft. centres, and the wheel base of each truck is 5 ft. 2 in. Each truck is fitted with a swinging bolster beam, to take up the lateral motion of the car. After a thorough and careful investigation of the best method of applying the motors, the system adopted now is to apply the propelling power, consisting of two 15 h. p. motors, to one truck only, the other truck being idle. The Robinson radial car, Fig. 30, of which there are about 50 on the West End road, and of which we present a cut, has also given remarkably good satisfaction, and is built by the Robinson Electric Truck and Supply Company, of Boston. These cars are 36 ft. 4 in. over all, 28 ft. length of body, 15 ft. wheel base, and have a seating capacity of from 42 to 44. They are all fitted with Robinson's standard electric radial steel trucks, the axles of which become radial to any curve which they may be on, and pass around curves with ease and smoothness. In the case of the Robinson car, one 15 h. p. motor is attached to each of the end axles, the middle axle being idle, and helping simply to guide the other axles, and support a small part of the weight. These cars also are of elegant design, and are beautifully finished both outside and inside.

XX.—THE CAR MOTORS.

The motors of all the cars are of the Thomson-Houston type, and have given wonderful results, working now every day with perfect uniformity and giving a minimum of trouble. At first all the cars were equipped with the "F 30" type, having the ordinary double reduction gear, but now the "S. R. G.," or single reduction motor is rapidly taking their place, and giving better satisfaction. This motor has a Gramme armature, and as it does not require to run at so high a speed, and has only one set of gearing, it is much more quiet and is also much more efficient. As has been said, each car is equipped with two motors, and each motor has a reversing switch, so that each armature acts upon its own field, thereby maintaining an even distribution of power between the two motors. In the nature of things it is not unlikely that even greater improvements will yet be

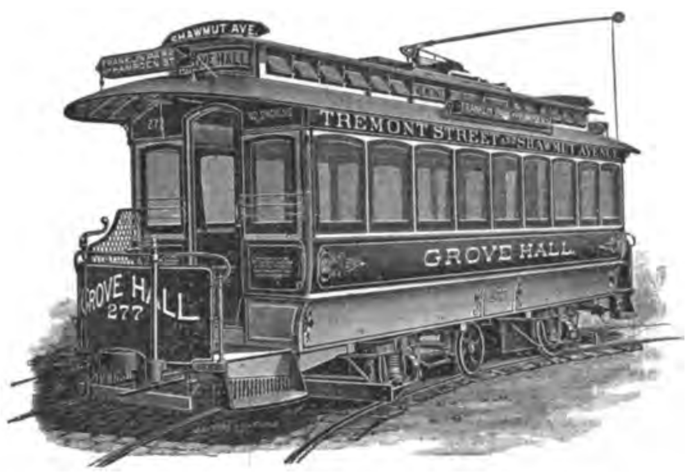


FIG. 30.—ROBINSON RADIAL CAR.

made in the motive power, continuous experiments in this direction being vigorously carried on by an efficient corps in search of further knowledge.

XXI.—PERSONAL.

By way of conclusion a word is due to the men who have put into execution this great work, and have carried out all the details of the enterprise. First and foremost, of course, is Mr. Henry M. Whitney, the leading spirit of the whole undertaking. He was born in Conway, Franklin county, Mass., in 1841, on October 22, exactly 40 years ago. The public schools furnished him with his early educational training, supplemented by one year at Easthampton Seminary.

His entrance upon a business career was as a clerk in the Conway Bank, where he remained three years. He then went to the Bank of Mutual Redemption, Boston; was afterwards clerk in the navy agent's office for one year (1860), and was then engaged in New York City in the shipping business.

In 1866 he became Boston agent, and in 1879 president, of the Metropolitan Steamship Co., Boston, which position he still holds. In 1887 he was elected president of the West End Street Railway Co., the largest street railway in the world, and a corporation controlling all the street car lines now running in the city of Boston. He is also president of the Hancock Inspirator Co. Mr. Whitney has brought to the presidency of the West End Street Railway thorough business experience, financial integrity and inventive genius. Before him and his associates lies the task of solving the problem of rapid transit in the city of Boston. The movements so far made toward bringing order out of chaos have been eminently successful.

While Mr. H. M. Whitney, the general manager of the West End Company, has been the prime mover in equipping Boston so thoroughly with electric street railroads, the details of the station and the outside construction have been admirably designed and carried out by Mr. F. S. Pearson, the chief engineer, Mr. L. J. Hirt, his assistant in the mechanical department, and Mr. L. S. Dumoulin, in the electrical department, who, by their united efforts, have produced a system of electric railways, with the adequate power houses, which leads the civilized world to-day. Mr. F. S. Pearson was born in 1861, and graduated at Tufft's College as a chemist and mining engineer, afterwards graduating in 1883 in the course of civil engineering. He also pursued the studies of electrical and mechanical engineering and graduated in these branches later.

F. S. Pearson.

Mr. Pearson was employed in Virginia, Texas, and South America as a mining engineer, and was later employed as an instructor in chemistry at the Boston Institute of Technology in 1879-80. Afterwards he became instructor in mechanical engineering and higher mathematics at Tufft's College, which position he held for three years. About that time also he formed business connections, becoming general manager of the Somerville Electric Light Company and treasurer of the Somerville and Woburn Electric Light Companies. He was also the treasurer and manager of the Halifax Illuminating Company, of Halifax, N. S., and formed the company of Grant, Pearson & Company, doing a general engineering business in New England. Mr. Pearson joined the West End Street Railway Company in 1889, and has had ever since complete charge of the designing and erection of the station, and the necessary outside structure. Mr. Pearson, though quite a young man, has undoubtedly made his mark as an electrical engineer, and his advice is eagerly sought in designing new electric plants.

Mr. Pearson is particularly fortunate in his two assistants, Mr. L. J. Hirt and Mr. L. S. Dumoulin, who have done magnificent work in their departments, Mr. Hirt assisting in the general mechanical department, and Mr. Dumoulin looking after the electrical department. Mr. Hirt was born in Paris, France, in 1854, and was educated at the École Professionel de Guebwiller, in Alsace, afterwards finishing as improver at Esher Weies & Company's marine shops, in Zurich. He afterwards entered the Northern Railroad shops of France, where he remained for one year, there after gaining a five years' general experience in England in various engineering capacities, after which he came to the U. S., where he has had a varied engineering experience for the past 10 years. Two years of this time was spent as traveling mechanical engineer for the Hill Clutch Works, of Cleveland, and he has assisted in designing and erecting many of the most important electric stations in the country. Mr. Hirt has now been with the West End Company about two years, and all the drawings of the station have been gotten out under his personal supervision; and he has proved himself a valuable man and well worthy of his position.

L. J. Hirt.

Mr. L. S. Dumoulin, who has attended to the electric work, both in the station and in the outside construction, was born in Liverpool, England, in 1845, and has been connected with the electrical business all his life, having started in the Eastern Telegraph service in its early days. He was then for a number of years connected with the submarine telegraph service in different parts of the world, entering the electric light business in London about 1875. Mr. Dumoulin came to the United States in 1879, and was at first connected with the Daft Electric Company during the early stages of electric light and power development. Later he became connected with the Electro Dynamic Company, of Philadelphia, and the Accumulator Company of New York, joining the West End in October, 1889. Mr. Dumoulin has thus brought to the West End Company a vast fund of electric experience, and well has he filled his position, working night and day to accomplish his object, until to-day he has succeeded in getting the vast system of electric cars working with perfect smoothness and reliability.

L. S. Dumoulin.

XXII.—CONCLUSION.

In the foregoing pages it has been my endeavor to describe in detail each feature of the central power station, including also, in a limited measure, the outside construction. In conclusion, a few words descriptive generally of the work accomplished by the West End Company in their electric system may be found interesting. The station itself has been finished in as complete a manner as modern science could suggest. The building is provided with a complete system of drainage, a complete system of fire hose and pipe connections in case of fire, and the whole building is absolutely fire proof throughout, being wholly composed of stone, brick, concrete and iron. In addition, fire proof windows and doors have been provided, and a complete system of electrical signalling between each department. At each engine will be erected a tastefully designed oak cabinet, on which will be mounted annunciator boards connecting with the generator-room floor and the switch or controlling room. As has been already mentioned, the growth of the business has been amply provided for, and in addition to the 26,000 horse-power which is being installed in the station described above, the West End Company are erecting another large station in East Cambridge, which will have a capacity of 9,000 horse-power when completed, and 6,000 horse-power is at present being installed. The old Allston station will also be kept in service, and this is equipped with 1,120 horse-power, the power being derived from Armington & Sims engines, with Thomson-Houston and Edison generators. It is worthy of note that the complete drawings and designs for the station have been made by the West End Company, who have employed an efficient corps of engineers and draughtsmen, and no outside companies have had contracts for construction, the whole of the work being supervised by the company's engineers. When the drawings of the transmission machinery were completed they were submitted to Professor Thurston, of Cornell University, who, after a thorough examination and recalculation of all the parts, together with a thorough investigation of all the strains to which such a station may be subjected from overload, etc., or when under heaviest duty, reported that everything was well proportioned for the work. Proof has already been had that the calculations were correct, as such parts of the station as are already finished have been put into daily service without the slightest hitch. As regards the economy of the station, it is interesting to note that it has been guaranteed by the engine builders that the Corliss engines will be run on 13 pounds of steam per horse-power in the cylinders, and from their actual experience in operation it has been estimated that the plant will produce an electrical horse-power at the switchboard on considerably less than two pounds of coal, while it is confidently believed that the entire system of cars can be run at a cost not exceeding seventeen cents per car mile, and probably considerably less. One great advantage in a station equipped with large engines and counter-shafting, as in the station just described, is the capability of loading each engine to its full capacity, where it necessarily works at its full economy; the belting also gives a great flexibility to the system, enabling the generators to overcome any great shock owing to sudden overload or short circuit. Experience will doubtless show many interesting new developments, and it is safe to assert that the working of the electrical system in Boston will be carefully watched by engineers in all countries. The West End Street Railway Company have succeeded in making Boston probably the most interesting city in the United States, from the present

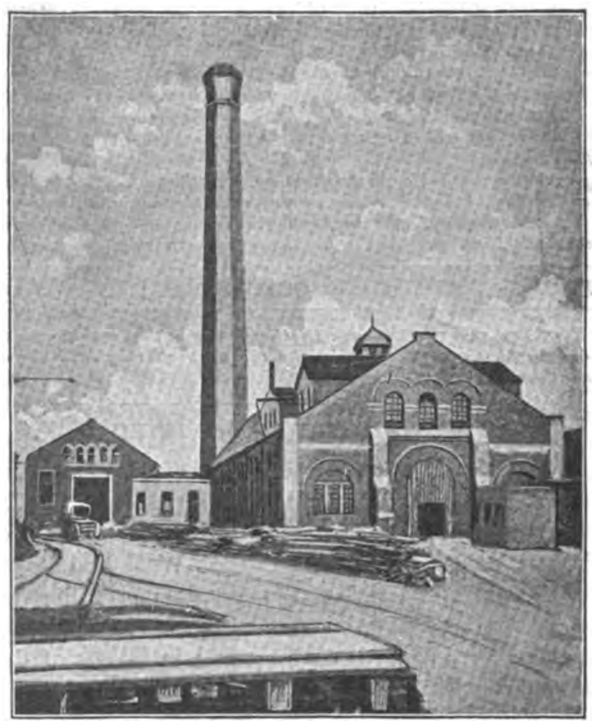


FIG. 31.—READY FOR THE WORK.

electrical point of view, and assisted materially in making it a centre, in America, of electrical science, as it has been for generations a centre of literature, culture and refinement.

A LEAD ALLOY FOR ACCUMULATOR PLATES.

The following lead alloy for accumulator plates is proposed by a M. Worms. It consists of 945 parts of lead, 22 of antimony, and 13 of mercury. The lead is melted first, and the antimony added, the mercury being introduced as the molten mass is run into the mould. The result is said to be an alloy of lead which can be easily split up into comparatively thin sheets.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XII. NEW YORK, OCTOBER 21, 1891. No. 181.

I have far more confidence in the one man who works mentally and bodily at a matter than in the six who merely talk about it. —Faraday.

ELECTRIC RAILWAY WORK IN BOSTON.

A LARGE part of the present issue of THE ELECTRICAL ENGINEER is devoted to a description by our New England editor, Mr. A. C. Shaw, of the work done in connection with the electric system of the West End Railway Co., of Boston. This article of 19 pages, copiously illustrated, is in fact the fullest account that has ever been published of an electric road, and is only equaled in fulness of detail by the article printed in our columns some months ago on the electric railway system of Buffalo.

The subject is evidently one of the utmost importance, and well deserving of the space and attention thus allotted to it. Mr. Shaw's article not only traces the history of the road, but touches upon many details of construction and operation. In some respects it recalls features in the series of New England electric light stations described recently in these pages, but electric railway work has many points of differentiation, and is therefore worthy of close study for its own sake.

We are free to confess that much as we admire the engineering skill and ability manifested in this great enterprise, our conviction has still to be formed that the best plan was adopted. There are various elements of doubt. One is as to whether the method of power transmission secures the best type of station and the highest efficiency in operation. Another is as to the best size of the units of engine and dynamo. The doubt arises in one's mind whether, if the plant had to be put in again, it would be put in upon the same plan and lines.

Yet we are very willing to accept the plant as a magnificent exemplification of the possibilities of electric railroading and of the future of the industry. This West End Road makes a memorable stage in the progress of the electric railway art, and the men who have been prominent in carrying out the work as set forth in our pages, may well be proud of their respective shares in its conception and execution.

THE CHICAGO ELECTRICAL CONGRESS OF 1893.

IT is encouraging to see that the good work begun two years ago in preparing for an electrical congress is already bearing fruit. The subject and the present situation were the theme of a very interesting address last Monday before the Chicago Electric Club by Dr. Elisha Gray, who, as was announced in our columns last week, has accepted the chairmanship of the Committee on Electrical Congress of the World's Fair authorities. With regard to the proposition, Dr. Gray said: "The movement as yet is in a formative stage, and much thought must be given to it before a detailed programme can be formulated. An advisory council must be appointed from the most eminent electricians from this and other countries. Some one, or more than one, must visit and confer with the noted men of the world, and no stone should be left unturned to make the Electrical Congress of 1893 the most important that the world has ever seen, not only in point of numbers, but in the eminent character of the men who attend, and the excellence and great importance of the work done."

This is well put, and the preliminary work cannot be undertaken too soon. Just what the Congress will be may be gathered from the following paragraph in Dr. Gray's address:

"The general outline of the Congress will probably be as follows. It should be divided into sections according to the various interests represented. First there should be a section devoted to the more purely scientific phases of the subject. This section should be composed of the most eminent scientific men in this and foreign countries. The standards that were adopted ten years ago will have had twelve years of trial by the time the Congress assembles. It may be that other units should be added to those already adopted, or that better definitions may be given to those already in use. Papers should be read by different individuals relating to the different theoretrical and scientific phases of the subject. Other sections should be organized, in the various interests of applied electricity; the number of which will be hereafter determined. In order to give all a chance to see and hear the great men of the world, all of the sections should meet together, on stated occasions, forming one grand general Congress, to listen to papers and discussions by the most eminent men of the world in electrical matters."

Dr. Gray offers the further suggestion that the various electrical bodies meet at Chicago in 1893. This will probably be done, although it is a matter to be determined whether their meetings should be held at the same time as those of the Congress. If they are, there will be apt to be too much of a good thing, but if they are not, it will be difficult to get electrical men together two or three times. The best way will probably be for the various societies to meet at the same time as the Congress, but provide very light programmes of their own. As a matter of fact, only two such bodies will really be affected, namely, the American Institute of Electrical Engineers and the National Electric Light Association; and the Congress will simply be doing the work of the former body on a larger and more comprehensive scale for the time being.

THE CENSUS OF THE ELECTRICAL INDUSTRIES.

WE have been favored with copies of the letters passing between the various departments at Washington as to the proposed census of the electrical industries. It is cheering to see that so many kind words are said in its behalf, but it is very apparent that little or nothing can be done unless the means are furnished to the Superintendent of the Census for prosecuting the scheme as laid out so carefully and ably by Mr. Allen R. Foote. All told, the electrical applications in America to-day rank probably among the first five industries, and yet we believe it is the only one for which the Government has not used its authority in order to secure definite data and information that would be of the utmost value and benefit. Every one knows that it is only the Government that can get this information, and therefore, unless the present effort is sustained and carried through, we shall have to wait another ten years, or until 1900, before anything can be done. The result will simply be serious loss, annoyance and trouble to everybody connected with electrical pursuits in America. Electrical engineers have the best reasons in the world for hoping that Congress will at least enable the Census Office to carry out this part of its programme.

LONDON'S UNDERGROUND ELECTRIC ROAD.

SOME of our New York papers have lately given up their columns to a discussion of the London electric underground road. The *Evening Post* has published several letters on the subject, the *Times* has had an admirable communication from a staff correspondent, and the New York *Sun* last Sunday devoted nearly a whole page to an illustrated description of the road and its operation. The appearance of the last-named article is the more refreshing, because the *Sun* has been systematic and even contemptuous in its method of opposition to rapid transit. The correspondent of the *Sun* is, however, compelled by the evidence of his eyes to confirm the favorable report made by the writer in the *Times*, who, if we mistake not, is the city editor, Mr. Lowenthal, that gentleman having recently returned from a trip abroad.

There is little that is new in any of these statements except the fact that they bring the inspection by keen and intelligent critics down to date. The *Sun* writer winds up by saying: "The City and South London Railway is an engineering success. Unfortunately it has not been a financial success." Yet, as he himself admits, the road was an experiment; it does not tap any of the great streams of traffic, and it was not supposed it would prove so effectual a demonstration of the possibilities. That such methods have abundant financial promise is seen in the fact that a new road, of which Mr. Lowenthal makes brief mention, is being actively pushed to traverse London directly from east to west, along a main artery of travel. That road, we predict, will be enormously successful, and it will embody many new ideas, and improvements going far to meet the few objections that have been raised.

Be that as it may, the practical success of electricity as a motive power has once more been shown. As a matter of fact, the electric power is the part of the question attracting the least attention; it "goes without saying." We have ourselves been in favor of the Greathead tunnel system not because it used electricity, but because it meets the other conditions of the problem. Even with such a near-surface system as the New York rapid transit experts have proposed, electricity will still be the motive power, but all the old difficulties of rights of way, existing franchises, etc., crop up again, and we cannot see that any advance towards the solution of the problem is secured. When we remember that only two or three months ago the objections to underground travel were made chiefly on the score of the inadequacy of electricity, and called forth a flat-footed challenge from Mr. Frank J. Sprague, one cannot but feel that in this shifting of the point of criticism, electricity has gained another victory. We are willing to stand by what Mr. Lowenthal says, and by the letter in the *Sun*, erewhile the bitter opponent of the whole thing.

THE NECESSITY OF STANDARD NOMENCLATURE.

IN the course of an able series of articles on the Frankfort Electrical Exhibition in *Industries*, Mr. James Swinburne writes as follows: "The indefiniteness of electrical nomenclature has led an important American contemporary (THE ELECTRICAL ENGINEER) to accuse us of writing about multiple currents without being acquainted with Mr. Tesla's work. We refer to the open and closed armature coupling as possibly being German modifications; in fact, we believe the interlinked coupling has been claimed as an important advance. We take it that our contemporary thinks that when referring to closed circuits we wrote of the ordinary short-circuited Tesla machine as a German modification. We need hardly assure our readers that we have studied the ordinary Tesla motor, and would scarcely venture to write on multiple currents without some acquaintance with both American and Continental practice, as well as information from experiments of our own."

In conclusion, Mr. Swinburne says: "We also fail to see that the triple-current is any real advance beyond the double-current machine, to whose development Mr. Tesla has devoted so much energy. Mr. Tesla in America and Messrs. Hutin and Leblanc in France are making progress in the direction of splitting a single into a double current by means of self-induction, capacity, and resistance suitably arranged. The solution of the problem of small motors may lie in this direction, but we do not think it lies in multiple-current motors, which do not fit the present systems of lighting.

"In mines, especially in dangerous mines, where it is most important that there should be no sparks, and where simplicity is demanded, the multiple current will probably come into general use; but at present it does not even promise a solution of the problem of alternating motors on supply circuits. What is asked for is a small motor to suit existing alternating circuits; what is offered is a motor which demands a new and complicated system of supply to operate it."

What Mr. Swinburne suggests as to the necessity of standard nomenclature is true. Not less true are his remarks relative to Mr. Tesla's priority in this field of work. Our recent narration of the facts in connection with this line of electrical application, showing Mr. Tesla's record in the matter, still stands; and the only inference can be that we ascribed to him no more than is fairly his.

ELECTRICAL WELDING AT THE PASSAIC WORKS OF THE INTERNATIONAL OKONITE CO.

The enormous advantages posessed by automatic welding machines over the old method of hand splicing are nowhere perhaps more clearly shown than at the works of the International Okonite Co. (Limited), at Passaic, N. J. Since the installment of the first Thomson welding plant in this factory the hand process has been entirely abandoned, and a visit to the works now shows an enlarged welding plant working continually, and giving the most complete satisfaction.

The generator is a self-exciting, constant potential alternator, of a capacity of 30,000 watts, belted direct to a Ball automatic engine, provided with extra heavy or "railroad" fly-wheels in order to maintain constant speed during the sudden demands on the generator. The welders used are what is known as type "1 A." for iron armoring or sheathing wires; two of type "2 A. A." for copper from No. 6 A. W. G. to No. 20 A. W. G.; two of type "10 A. A." for copper from half inch to No. 6 A. W. G.

In the accompanying illustrations, Fig. 1 shows two welders, one of large size, and one small bench machine, while Fig. 2 is a large welder in use in the armoring department.

After the wires are prepared for the weld, *i. e.* clamped and given the proper projection, the time of application of the current is but a small fraction of a second for all of the smaller sizes, such as telephone and telegraph wires, and the heat necessary to form a perfect union is all concentrated at the tip ends of the abutted pieces. Advantage is taken of this fact in welding wire, already insulated, into continous lengths, it being only necessary to remove the insulation far enough for the clamping process. The average daily output of copper, including all sizes, is about five tons, averaging about 200 welds.

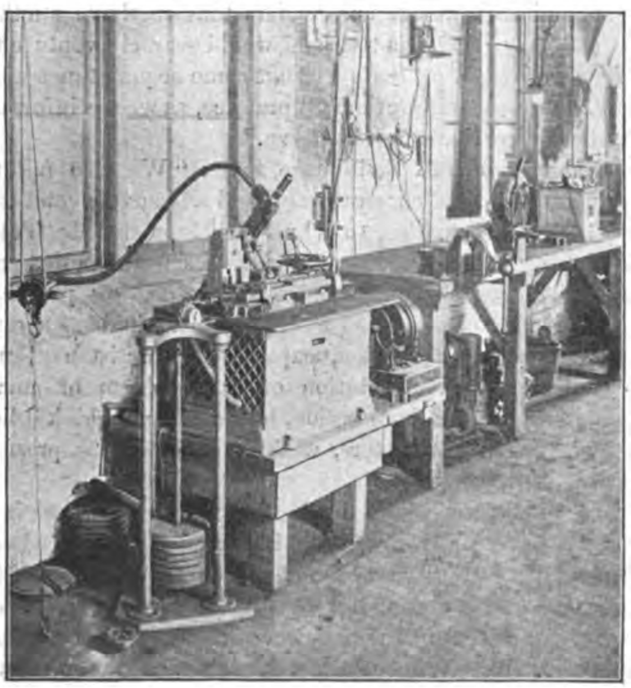


FIG. 1.—ELECTRIC WELDING AT THE OKONITE FACTORY.

The present plant is now running at almost full capacity, as the welders are situated in different parts of the factory, and welds are frequently made simultaneously on all welders, making very heavy and sudden demands upon the generator. The large 3,000 watt transformer in the testing department is continously operated by the small generator, taking 300 volts and ten amperes for the primary, and giving a maximum of 20,000 volts in the secondary.

If electric welding as done at the Okonite factory is to be taken as any criterion, it is a most assured success. At first glance it looks like the simple application of a current to obtain required results. Such is not the case, however, as different wires require different projections, of and pressures upon, abutted pieces, and different current strengths, and the current must be interrupted at the proper moment. To apply proper conditions to every wire in making a weld, however, requires no extra skill on the part of the manipulator. In the case of end pressure on the abutted pieces, he simply applies the number of weights given in a table which has been previously worked out, and varies the current strength for each wire by simply moving the shield on the reactive coil placed near the welder.

FIG. 2.—ELECTRIC WELDING AT THE OKONITE FACTORY.

THE NEW A. B. & B. RESISTANCE METAL.

The Aluminum Brass and Bronze Company, at Bridgeport, announce a new resistance metal in wire, sheet or castings, which seems to be a very important contribution to this class of material in electrical engineering. The wire samples we have seen resemble ordinary copper wire on the outside, and have a pinkish white tinge at the surface of fracture. The wire is very strong, without losing much ductility. The torsion test shows over eighty twists in six inches for an annealed wire, which still possesses 70,000 lbs. tensile strength to the square inch. The hard drawn wire runs to 100,000 lbs. tensile strength, with about forty twists in six inches. Combined with these admirable mechanical qualities, the wire has the remarkable resistance of thirty-five times that of copper with a temperature co-efficient of less than one-tenth of that of German silver; furthermore, the wire is cheap. We understand that, by having the resistance lower than in the samples described above, the tensile strength can be increased up to 140,000 lbs. per square inch. These particulars relate to wires .080 inch diameter and thereabouts.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

"I am here" is the Duke's motto; also the Advertiser's.

NEW SOMOFF INCANDESCENT LAMPS.

Fig. 1.

NEW applications of miniature electric lights spring up almost daily where they were the least expected to appear. As an example of this, Mr. J. L. Somoff, of No. 1 Ann street, who is now devoting his entire time to the manufacture of miniature incandescent electric lamps, mentions a number of city residences lit by "pea" lamps connected in multiple wires on a 110-volt circuit. The "peas" are enclosed in miniature colored Japanese lanterns, hung about a dozen in each room.

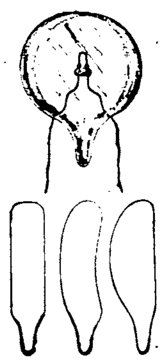


Fig. 2.

Some other residences use low candle-power lamps, having the appearance of the ordinary 16 c. p. lamps and connected as before mentioned.

Fig. 1 presents one of these low candle power lamps. The base is silver plated and fits either Edison or Westinghouse sockets. One side of the globe, if desired, is silver plated and acts as the most beautiful reflector.

Fig. 2 is a lamp much in favor with surgeons. As its name, "tongue-depressor lamp," implies, it is employed in connection with an instrument in common use with the medical profession.

The utility of such a lamp is obvious, since it can conveniently be mounted upon the upper side of the tongue depressor to supply the needful light.

The lower part of Fig. 2 presents three sectional views of the globe. It is flat, with sides either paralleled, plano-convex, or concavo-convex; and the curvature of the sides, one of which is silvered or platinized, serves the better to concentrate the light upon the required part of the mouth.

Fig 3.

Fig. 3 is a more substantial combination of a lamp with a tongue depressor, where the latter serves also as a switch to make and break the current. All metal parts of the instrument are plated with platinum to insure cleanliness and prevent corrosion.

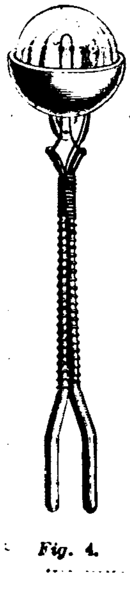


Fig. 4.

Fig. 4 is a "tulip" lamp without the "tip;" the air being exhausted from the lower end of the globe. The lower half of it is encased in a platinum reflector, and the ends of the two copper rods, upon which the lamp is mounted, are made to fit the handles of electro-cauterizing knives now in almost universal use.

THE D. M. STEWARD MANUFACTURING CO., of Chattanooga, Tenn., report that orders for lava insulators are greatly in excess of the business they have enjoyed at any time since they have been in business. Their request "write for samples" brings replies in almost every mail, and postage on samples has become quite an item.

LONG BRILL CARS FOR ELECTRIC ROADS.

A GROWING tendency to the use of longer cars, where the motor power is other than animal power, has developed the fact that but very little can be added to the length of a car of the ordinary type without considerable sacrifice of the time taken to load and unload passengers, and an increased difficulty in collecting fares on long cars having a platform at each end. The adoption of electricity and cable as motive powers, and the consequently quicker transit, has increased in a wonderful degree the number of passengers carried, and the railroad companies naturally seek to add to their carrying capacity in the most economical manner. To increase the seating capacity in a car without adding to the length on the street of the present horse car, and to attend to the passengers and to collect the fares by the employment of one man as conductors are the two directions by which this economy is reached. In a new car just completed for the Lindell Railway Co., of St. Lous, by J. G. Brill Co., the economical features above referred to are accomplished. This car is the invention of John A. Brill, vice-president of the J. G. Brill Co., and the novel features embraced in it are covered by three patents. The most evident novelty is that the car has no end platforms, but has a vestibule or platform enclosed on three sides near the centre of the car, which is open only on one side of the car and connects the two compartments by doorways. The front platform of an ordinary car has no use except for the motorman, carrying no passengers, and in this car the whole of one platform with its unnecessary length and weight is dispensed with.

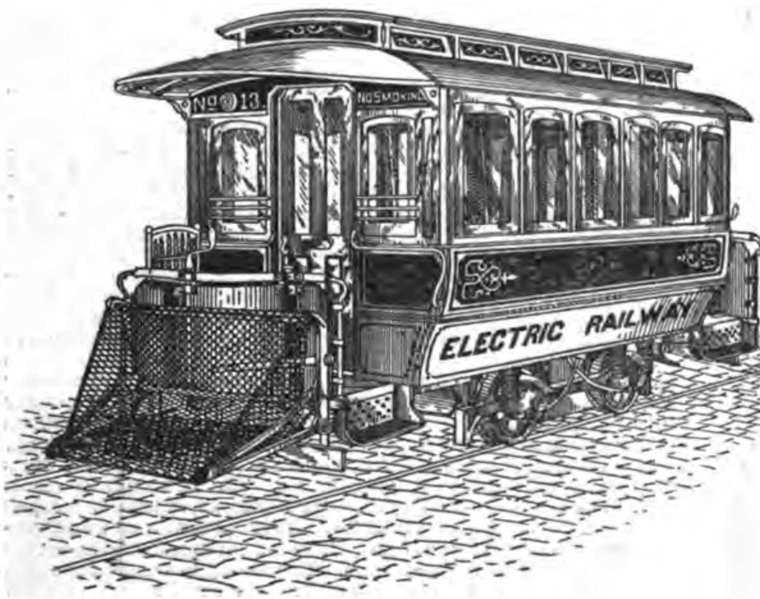
The car is divided into two compartments separate from each other; the forward compartment is for the usual mixed passengers, and the rear compartment is intended primarily for the use of smokers, the larger being 17½ ft. long, and the smaller 10½ ft. long. The seats in this car are placed transversely, with capacity for two persons on a seat, on each side of the aisle, and there is a seat on the closed side of the vestibule for three persons. At one end of the single step there is a convenient space guarded by a stout handrail of polished brass for the conductor to stand in, from which point he has complete control of the car, and can easily reach passengers who require his assistance in getting on or off the car. The seats in the car can be arranged if preferred in the usual manner of street cars, that is, longitudinally on the sides. The total seating capacity of the car is 46 persons. With this arrangement of the entrance near the middle of the car it is evident that the passengers will not require so long a time to get to or from their seats as they would in case where the entrance is placed at one end, and with the same reasoning the conductor can reach both ends of the car for collecting the fares with greater facility, and having the advantage, one man can collect all the fares and attend to all the passengers. An ordinary horse car is 23 ft. long, and with the horses attached occupies 35 feet in the street, seats 22 persons and requires one conductor. The new style of car is only 31 ft. 6 in. extreme length, seats 46 persons, and can be worked with equal ease by one conductor. As it carries as many passengers as two ordinary horse cars, there is a saving of one conductor for a given number of passengers. The saving in wages alone on a line using 100 cars is from $200 to $250 per diem, representing an annual saving of over $70,000, an amount sufficient alone to pay a dividend greatly in excess of the average dividend on street railroads. In cities with crowded streets, like New York, Philadelphia, Chicago, the saving of one-half the street space of cars is an item of enormous advantage. And this car is only 7½ ft. longer than the adopted size of motor cars with vestibuled ends, which seats only 22 persons. The motorman stands in a place four feet long and two and one-quarter feet wide, well sheltered, but with complete view of the track. This space is partitioned off with mahogany panels and plate glass sash, by which he is freed from all crowding and interference by passengers. Another important advantage which this long car has over a train of motor car and "trailer" is the superior control in stopping the car, which in the train cannot be made to act as promptly as desired unless by use of the automatic brake, which is effective, but costs $300.

The Lindell Railway Co. with its characterized generosity and desire to give its patrons the very best that can be had, has ordered this car to be finished in the most elegant manner, with solid mahogany, polished plate glass, embroidered linen shades, polished brass mountings, and seats where a passenger will not have to struggle for the 17 inches usually allowed to him. The successful working of this long car with electric motors is dependent, however, on the use of Brill's patented maximum traction trucks, on which more than 90 per cent. of the traction is upon the two pair of driving wheels of the trucks; and the peculiar form of the truck entering the bottom frame of the car body sets the car so low that it required only a single step of the usual height at the entrance. The use of this style of truck on the Newark Passenger Railway has made a great success of the operating of long cars at a time when the company was on the point of abandoning their use as being a failure, by reason of the deficient traction and excessive height of the car body, which caused two steps to be necessary.

THE APPLEYARD FENDER FOR ELECTRIC CARS.

EVER since the introduction of electric and cable cars there has been a growing feeling that there should be a guard on the front of the cars to protect people who happen to be in the way. There have been a number of accidents to life and limb, which, though unavoidable, would have been free from serious injury had there been some kind of protection on the front of the car. Acts have been passed to enforce the use of fenders and guards, and the board of railroad commissioners have at times required an arrangement of some kind which would render it impossible for a street car to pass over a body lying in the way of a car or knocked down by a car. We take pleasure, therefore, in illustrating in the accompanying engraving the Appleyard patent safety fender, which appears to fill all the requirements. The fender is at the front of the car and projects forward from the platform about four feet, with its lower edge about nine inches from the track, and is adapted to receive and hold the body of an individual or animal that may be caught upon the track and carry it along without injury.

To guard against the possibility of injury to a person falling into the receptacle by breakage of the rope net or by its sagging, a second or wire netting is attached to the lower portion of the frame. It will be seen that the front portion of the fender is located so near the road-bed or track that in striking a person it will inevitably cause the person to fall into the soft rope net and not suffer injury. As an additional means of safety a scoop is placed beneath the body of the car, so that, should a person fall in the act of crossing the tracks, he would pass under the first fender and on going under the car he would strike a lever, which would release a powerful spring and cause the scoop to come down and catch whatever obstacle might be in the way. The scoop is made to travel on the road-bed when down, so that it would be impossible for one to come in contact with the wheels.



APPLEYARD STREET CAR FENDER.

When not in use the fender can be folded up close to the dashboard, so that at the end of a route, when it is not required, it is not necessary to change the apparatus, but simply to fold up the one fender and let down the other ready for action.

This fender has already met with the approval of several street railroads and is being introduced by the Chester Manufacturing Company, whose address is 625 Exchange Building, Boston.

THE MINNEAPOLIS ELECTRIC RAILWAY.

THE article printed in our columns last week with reference to the results on the Minneapolis electric railway has naturally attracted considerable attention, showing as it does the remarkable superiority of electrical methods. It therefore deserves to be pointed out, by way of elucidation, that the road is in reality an Edison one, and not wholly run on the Thompson-Houston system, as might be inferred. The Minneapolis street railway has 128 motor cars, 60 miles of double track, and about 2,500 kilowatt station capacity. The St. Paul road has 80 motor cars, about 35 miles of double track, and 1,800 kilowatt station capacity. The cars take on an average about 6 c. h. p. per car. These roads were built from plans and specifications of the Edison General Electric Co., and the work of construction was done under the supervision of their experts.

HUNT ENGINEERING CO.

THE Hunt Engineering Co. have removed their offices from 238 Washington street, Brooklyn, N. Y., to 126 Liberty street, N. Y., where they will be pleased to see all their friends. This removal has been occasioned by the Brooklyn Bridge acquiring for terminal facilities the property occupied by them, necessitating an immediate removal on their part.

THE "ÆTNA" ARC LAMP INSULATOR.

The accompanying illustration shows a new form of insulator, designed and manufactured by Albert & J. M. Anderson, of Boston, for the purpose of suspending arc lamps so as to make a well-insulated support. It is called the Ætna arc lamp insulator, and a glance will at once explain its use.

The bell is a solid mass of Ætna insulating material, used largely for insulation in electric railroad work. The material is exceedingly strong and tough, does not crack or split under heavy blows, possesses superior qualities as an insulator, is impervious to moisture, and unaffected by atmospheric conditions or changes. The metal ring and spring clip are of brass, and will therefore not corrode, and no film of oxide forms over the insulating material to destroy its insulating properties in either dry or wet weather. The bell form offers maximum insulating surface, and is practically indestructible.

ÆTNA ARC LAMP INSULATOR.

This form of insulator has been found to be very effective. It is complete in itself, and all that has to be done is to press in the spring clip and hang up the lamp, the clip effecually preventing the lamp from being shaken out.

A NEW DOUBLE-DECK ELECTRIC CAR.

THE electric car recently designed by Mr. E. C. Sessions and Mr. C. L. Pullman resembles in general appearance the double-decked vehicles in common use in London and Paris. It is 32 feet long, 7 feet 4 inches wide, 14 feet 9¼ inches high, and will seat forty passengers on each deck. The car body is so arranged that passengers may enter at the centre of either side, where spiral stairs lead to the upper deck. Four stairways, combined with two at the bottom, separate toward the top, leading to either end of the car. The entrances at the centre occupy no more space than the end platforms on ordinary street cars. The lower car body consists of two compartments, each twelve feet long, with circular ends, seats being carried around the ends as well as at the sides. The upper deck is entirely covered with a canopy attached to the pilot house. The car is equipped with an electric chandelier and electric heaters in each compartment, and propelled by two Westinghouse motors of twenty-five horse-power each. The car rests on two trucks of special design, arranged with double-brake attachments, and a friction brake. The efficiency of the brakes was demonstrated by the stoppage of the car within its own length while traveling at a speed of twelve miles an hour in Chicago a few days ago. H. H. Sessions, manager of the Pullman Car Works, is the inventor of the brake attachment.

THE ELECTRIC MERCHANDISE COMPANY.

THE Electric Merchandise Co. will have their headquarters during the Street Railway Convention in Parlor 5, Monongahela Hotel, and from the position occupied by them in the electric street railway field, their headquarters will undoubtedly be a prominent feature of the convention. To no single company is the street railway manager as largely indebted as to this exclusive electric railway supply house. Owing to the well-recognized standing of the company and the success which has attended all their ventures, numerous offers have been made to them to handle other material, but it is their belief that the electric railway field is of enough importance to have at least one house devoted exclusively to that business.

Having a much larger experience than any other house in that particular line of business, and being altogether unbiased and anxious to furnish the best material possible, they give careful investigation to all devices offered to them or placed on the market by other companies. Their decision in matters relating to electric railway building and maintaineuce is recognized as authority by railway managers using all the different systems throughout the entire world. In addition to the very extensive printed matter furnished by the company, and which is certainly a great aid in deciding on the merits of different devices, the benefit of their wide experience is cheerfully given without charge to parties interested.

Samples of their complete line material will be on exhibition in their parlor during the convention, and careful examination is invited. The simplicity, combined with great strength and perfect insulation of their devices, are great points in their favor. The company has gone to great expense in perfecting a special composition bell insulator, as well as a simple but absolutely reliable clamp for holding the trolley wire. In many cases contracts with parent electric companies are made conditional on having the line devices of the Electric Merchandise Co. furnished.

Another matter which has been given great attention, and in the perfecting of which the company has spared neither time nor money, is the furnishing of an "ideal" rawhide pinion, one which under no possible circumstances will dry out or spread. They are now furnishing a pinion composed entirely of rawhide, with the necessary brass flange and free from glue or other objectionable foreign matter.

The position which the company has obtained received pleasant recognition some time since by the election of its manager, Mr. W. R. Mason, to the presidency of the Burton Electric Co. The result of this selection, and of the Electric Merchandise Co. as selling agents for the Burton electric heater, has been most encouraging to the company. The unique position occupied by the Electric Merchandise Co. has enabled them to place these heaters on a very large number of electric roads, and as the advantages of this method of heating are more generally understood they will unquestionably replace coal stoves, with their objectionable features of dirt, smoke, ashes and danger from fire.

In addition to a number of the representatives of the Electric Merchandise Co. who will be in attendance at the convention, they will have with them Dr. W. Leigh Burton, the inventor of the Burton electric heater.

E. G. BERNARD & CO.

MESSRS. E. G. BERNARD & Co., of Troy, N. Y., have recently placed an electric lighting plant of 100 lamps in A. J. Nuttall & Co.'s mill, Cohoes, N. Y. The firm's electrical display on the evening of the 15th, ult., in front of their warerooms, in honor of the unveiling of the monument, was exceedingly artistic, and attracted great attention from strangers and residents. A large corona of colored lamps, tastefully surrounded by the national colors in bunting, brilliantly illuminated the whole street, and was noticeable for a long distance. They have already received highly complimentary notices from the daily papers, and from prominent citizens, for the brilliant view afforded, and also as showing to how great an extent, and how easily, the electric light lends itself to the decorative art for balls, dinner parties and festive gatherings, as well as for store decorations and show windows.

THE NEW QUEEN CATALOGUE.

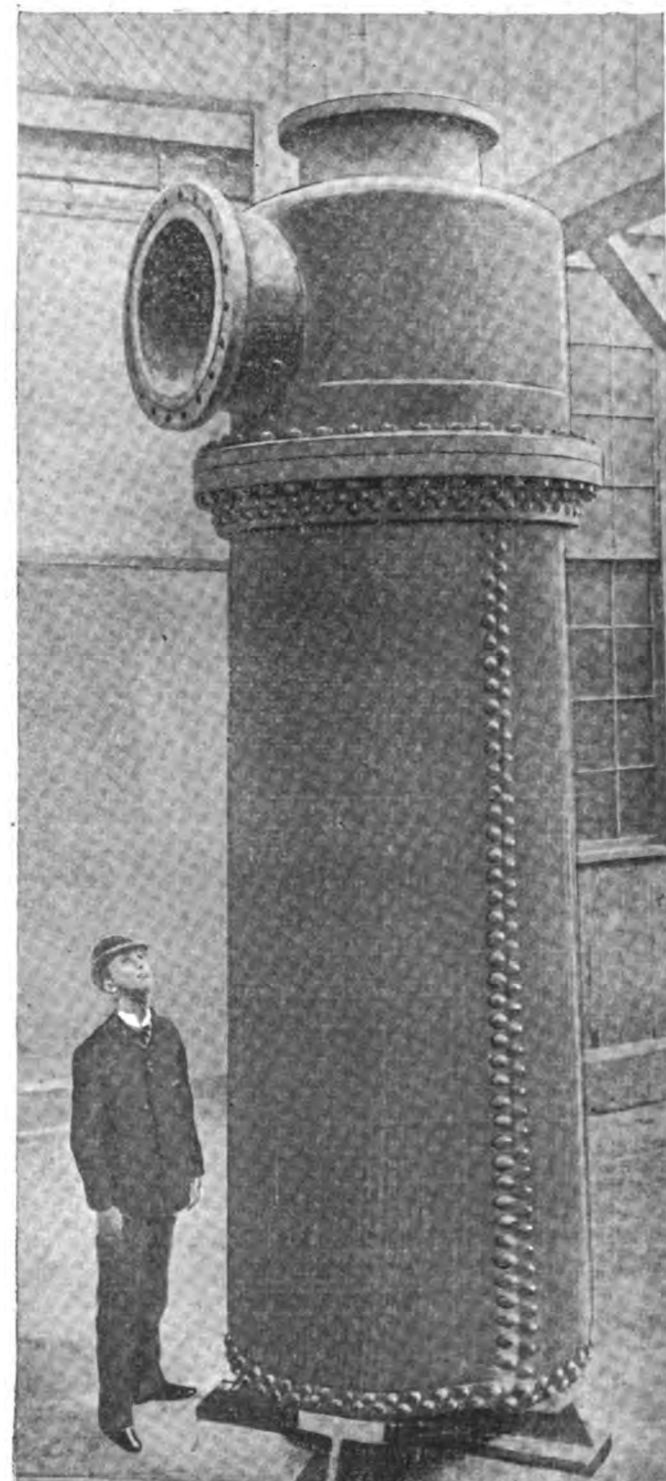
MESSRS. QUEEN & Co., of Philadelphia, have issued a new 124-page catalogue of their electrical testing apparatus and accessories, which in point of completeness excels anything of the kind previously issued by them. Among the apparatus described and illustrated may be mentioned their magnetic vane ammeters and voltmeters, hot wire voltmeters, electro-dynamometers, portable galvanometers, portable testing sets, electric light photometers, brackets, and cradle dynamometers.

MR. W. A. HATHAWAY, of the staff of the American Electrical Works, Providence, R. I., was married on October 15 at Edgewood, R. I., to Miss Louise H. Johnson.

AN IMMENSE STRATTON SEPARATOR.

Steam separators are now being recognized as a necessary adjunct of a perfect steam plant; the absolute certainty that none but dry steam will reach the engine being duly appreciated by every engineer.

The accompanying illustration shows what is believed to be the largest separator ever built for separating water from live steam. It was built by the Stratton Separator Co., of New York city, for



AN IMMENSE STRATTON SEPARATOR.

the Calumet & Hecla Mining Co., miners of copper ore on Lake Superior, Mich., and was constructed under the strictest requirements, and according to the specifications of Mr. E. D. Levitt, consulting engineer of the Calumet & Hecla Mining Co.

This immense separator is 3 feet 8 inches in diameter, 14 feet 5 inches in length over all, for a steam pipe of 21 inches diameter, and designed for a working pressure of 185 pounds. The shell is made from a single sheet of steel, and the top of cast iron gun metal.

The Stratton Separator Co. have furnished the Calumet & Hecla Mining Co. several separators for high pressure, that seen in our illustration being the most notable.

MESSRS M. R. MUCKLE, JR., & CO.

The above company are installing for Messrs. S. A. Crozer & Sons, of Chester, Pa., an incandescent light plant. The dynamo will be driven by a Westinghouse 10 inch and 18 x 10 inch compound engine.

About 380 lamps will be installed at present, placed on a large number of separate circuits, all separately controlled from the engine-room.

As a result of ten years' night and day use of the electric light and engine plant installed by Messrs. M. R. Muckle, Jr., & Co. in the Spreckels' refinery, Mr. Spreckels has ordered from them a 60 h. p. Westinghouse standard engine. This makes the sixty-third Westinghouse engine in use in this refinery.

Messrs. Chambers Bros. & Co., manufacturers of brick machinery have bought from Messrs. M. R. Muckle, Jr., & Co. a 35 h. p. Westinghouse engine to drive their electric light plant, which consists of a Thomson-Houston dynamo with a capacity of 350 lamps.

This purchase results directly from the investigation made by Cyrus Chambers, Jr., as president of the Bala & Marion Electric Light Co.

THE UNITED PRESS HEADQUARTERS, CHICAGO:

The offices of the United Press Association, in the new *Herald* Building in Chicago, are going to be the most complete and handsome offices of the kind in the country. The telegraph department will in itself comprise a large telegraph office, the instruments being of the most modern pattern, and highly finished, and beautiful specimens of the highest skilled labor. These instruments were purchased from the Central Electric Company, and are on exhibition in the salesroom of that progressive company.

AUTOMATIC SCALE COMPANY.

The Automatic Scale Company, a description of whose device appears in The Electrical Engineer of Sept. 30th, has just closed a contract with the United States Revenue Department for a large number of these scales. It is the intention of the Department to change the present method of gauging spirits and use these scales in the determination of the specific gravity of liquors, thereby arriving at the percentage of alcohol contained. The application of the automatic electric scale to this end is so obvious that its immediate adoption followed as a matter of course.

DAYTON FAN AND MOTOR CO.

The above company, of 10, 12, 14 and 16 South Canal street, Dayton, O., is in the field to supply fly and ventilating fans, electric and water motors, &c. Mr. W. B. Anderson is the president; J. A. Smith, vice-president; E. O. Waymire, secretary and treasurer; E. C. James, general manager, and W. F. Phelps, general superintendent.

U. S. ELECTRIC RAILWAYS CO.

We have been requested to state that the U. S. Electric Railways Co., of 10 Wall street, has no connection with the United States Railway Equipment Co. The former company says that it has had many inquiries as to the matter, and desires it to be understood that the concerns are entirely distinct and independent, and should not be confounded the one with the other.

THE BALL ENGINE CO.

The Ball Engine Co., of Erie, Pa., have received the following letter, which speaks for itself:

World's Columbian Exposition.

Ball Engine Co, Erie, Pa.

Gentlemen.—We started last night the 10x12 engine kindly loaned by you to us for our temporary power and lighting plant. I have to congratulate you herewith upon the start made, which I have no hesitation in saying was the prettiest I have known in my experience.

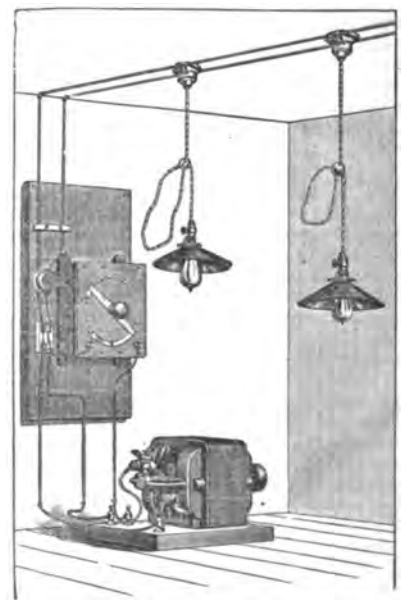
We started the engine under full load at six o'clock, and it ran until six o'clock this morning without the slightest trouble from heating or any other cause. I consider it a very valuable record.

Please accept my thanks for the promptness with which you filled our order, and for your liberality in furnishing us this engine.

Very respectfully yours,
J. C. Slocum, Mechanical Engineer.

A NEW BAIN ELECTRIC LIGHT PLANT.

A very compact electric light plant, simplified and relieved of all unnecessary features, is that recently designed by Mr. Forée Bain, of Chicago, and shown in the accompanying illustration. This apparatus is complete and ready for operation, and, it is claimed, will maintain without trouble its full load of 16 c. p.



Bain Electric Lighting Plant.

lamps. Various sizes of plants of this character are manufactured, ranging from 5 to 50 lights capacity. They are all carefully tested before leaving the factory, and any part of the entire plant can be furnished in duplicate.

ELECTRIC POWER IN INDIANAPOLIS.

A power-house is to be immediately erected by H. C. & M. P. Wright at the corner of Tennessee and Georgia streets. It will be four stories high, and will contain over sixty thousand feet of floor space, and will be equipped with heat, light, power, elevators, etc. The place is expected to prove a boon to small manufacturing interests, which cannot afford to buy their own plants. This is an enterprise for which both the Board of Trade and the Commercial Club have been working, and, while it is built by private capital, it will hold near relations to the Commercial Club, and will partake of the nature of a public institution. The plan embraces a scheme for greatly enlarging the capacity of the building when desired.

BERLIN IRON BRIDGE CO.

The Deleware Iron Company, owned and operated by Morris, Tasker & Co., of New Castle, Delaware, have decided to rebuild their plant which was lately destroyed by fire, and have placed the contract with the Berlin Iron Bridge Company, of East Berlin, Conn., for the entire plant, which will be constructed of iron from the designs of the Berlin Company. The work has to be completed by December 1st.

THE GERMANIA ELECTRIC CO.

Through its energetic treasurer, Mr. Otis K. Stuart, the Germania Electric Co. has secured the contract for building the entire plant of the Portland Electric Light Co., of Portland, Conn. The plant will start with 650 incandescent lights and 35 arc, and with engine and boiler capacity of 150 h. p.

RIES ELECTRIC SPECIALTY CO.

In the office of the Ries Electric Specialty Company, at Baltimore, hangs a magnificent set of resolutions elaborately framed, which was presented to their president, Mr. Elias E. Ries, and their vice-president, Mr. Lew. S. Greensfelder, by the board of directors, on Tuesday of last week. These resolutions were presented to the above-named gentlemen for their untiring efforts in behalf of the introduction of the new "Regulating Socket" for incandescent lamps, which was shown for the first time at the Exhibition of the National Electric Light Association, held at Montreal, Canada, September 7th, 1891. On each side of these resolutions hang photographs of the members of this Convention, taken in front of the Windsor Hotel. The display is neat, and the company look upon these as valuable souvenirs of this Convention, where their regulating socket received its introduction, and was pronounced "the feature of the Exhibition."

THE HARRISBURG IDE AND IDEAL ENGINES.

The firm of W. R. Fleming & Co., 174 Fulton street, New York City, selling agents for the Ide and Ideal engines, have been taking orders in such a persistent fashion, and in such quantities, that the factory they represent, the Harrisburg Foundry & Machine Works, have been unable to keep up with the increasing demand. Substantial additions have therefore been added to their extensive plant. All standard sizes of Ide and Ideal engines are now being built in quantity, and short deliveries will be the order. One of the most complete and finest engine-testing rooms in the country has just been completed and added to facilitate the large business now on hand.

A SEQUEL TO "KIND WORDS."

A few months ago the Fort Wayne Electric Co., through its energetic New York State agent, Mr. W. J. Morrison, published a most striking batch of testimonials under the title of "Kind Words." They have now issued a not less remarkable sequel. It consists of a batch of about 75 letters, from all parts of the country, to Mr. J. Findlay, of Ogdensburg, N. Y., by users of the Slattery alternating incandescent apparatus. The Fort Wayne Co. has been in the habit of making some pretty broad claims as to the merits of its apparatus. While it has such words of praise as these to support its assertions with, it can be no wonder that the system finds such rapid adoption everywhere.

OERLIKON MACHINE WORKS.

We are advised by the management of the famous Oerlikon Machine Works, of Oerlikon, Switzerland, that, owing to the rapid and continued growth of the Business, Mr. Emile Huber has become associated with the direction of the concern. Mr. C. E. L. Brown has resigned his position with the company as electrical engineer, it being his intention to devote himself to other special electrical work.

H. B. PRINDLE & CO.

Mr. H. B. Prindle, who for a long time past has had charge of the advertising and newspaper department of the Thomson-Houston Electric Co., with headquarters at Boston, Mass., has now established the above firm at Room 732 Exchange Building. He will not only continue in business of the same kind as that which has heretofore occupied his attention, but will have a special department for the preparation of catalogues and price lists.

BABCOCK & WILCOX BOILERS.

The Providence Steam Engine Co., Providence, is changing the drums of the boilers in the Narragansett Electric Light Co.'s station in that city to the Babcock & Wilcox system. The Babcock & Wilcox Co., of New York, has the contract for the alterations, which have been delayed until the job of putting in 1,120 horse power of its own boilers was completed.

DETROIT ELECTRICAL WORKS.

Mr. Chas. A. Benton, manager of the electric railway department of the Detroit Electrical Works, has recently visited Marion, Ind., and sold an 80,000 watt generator to the Queen City Electric Co., of that place.

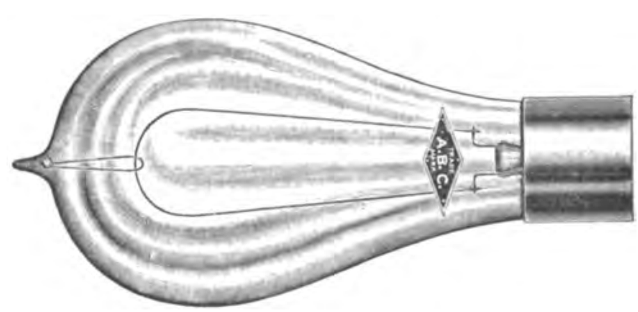
STREET RAILWAY STATISTICS.

Street railway statistics are given as follows by the *Street Railway Journal*: The total number of miles of street railways in the United States and Canada is 11,029, of which 5,442 are operated by animal power, 3,000 by electric power, 1,918 by steam power, and 660 by cable power. The total number of cars employed in the street railway traffic of the United States and Canada is 36,517, of which 25,424 are operated by animal power, 6,732 by electric power, 3,317 by cable power, and 1,044 by steam power. The total number of companies operating street railways in the United States and Canada is 1,003, of which 412 operate electric lines and 54 operate cable lines. The number of horses employed in street car service is 88,114, of mules, 12,002, and of steam motors, 200. It is interesting to note that since Nov., 1890, the number of horses employed on street railway lines has fallen from 116,795 to 88,114; that is, 28,681 in one year.

A NEW "A. B. C." RAILWAY LAMP.

The enterprising firm of Alexander, Barney & Chapin, of New York, have recently added to their line of "A. B. C." incandescent lamps one that is particularly intended for electric railroad usage. The high specific resistance of the "A. B. C." lamp filament produced by the peculiar methods of their manufacture enables the production of lamps with comparatively short and heavy filaments which, even unsupported, are well adapted for sustaining the vibration incidental to car use, and the strain produced by burning in an inclined position.

A supported filament must, however, necessarily offer advantages so long as the support is of such a nature as to produce no excessive abrasion at the point of support of the filament, and thereby shortening the life of the filament. The manufacturers of the "A. B. C." lamp have discarded the use of the platinum or metallic support, substituting in its place a carbon support.



New Railway Lamp.

As shown in the cut, a suitable length of carbon scarcely larger than the filament of the lamp itself, is bent with a sharp curve around the filament before the filament is introduced into the lamp globe, and its two ends are sealed close together by a drop of glass. This glass is subsequently sealed to the bulb at its tip during the operation of tubing the lamp for exhaustion. A support of this nature is practically invisible when a lamp is burning and has the advantage of being to a certain extent flexible. This relieves the filament from the injurious effects of moving sharply against an inflexible support with the consequent danger of loosening the filament connections and injury at its point of abrasion with the support. As such a carbon support will evidently withstand the heat given by a burning carbon filament, and as it itself is not traversed by current, there can be no danger of its wearing out during the life of the lamp.

Another possible advantage of the substitution of carbon with its low specific thermal conductivity for platinum is that the filament when brought against the support finds itself resisted in motion by a material similar in nature and to a considerable extent hotter than would be a metallic support, and thereby excessive and continuous localized changes in temperature are avoided.

BRUSH ELECTRIC CO.

Mr. Samuel M. Hamill, the secretary of the Brush Electric Company, of Cleveland, O., who has been in charge of the Eastern offices of the company, at No. 36 Union Square, for the past three years, has recently removed to Cleveland to assume the duties of general manager, under his present title of secretary, Charles S. Pease, the general manager of the company, having recently resigned.

The Eastern offices of the Brush Company, which have been for so many years located on Union Square, will be moved on October 1, to the Boreel Building, No. 115 Broadway, rooms 80-82. Mr. Hamill for the present will carry on the Eastern offices from Cleveland.

THE SHORT SYSTEM FOR EAST LIVERPOOL, O.

AFTER much competition the contract for electrical equipment to be used on the East Liverpool & Wellsville Railway has been awarded to the Short Electric Railway Company. The road will be about eight miles in length, connecting Ohio City, Wellsville and East Liverpool, with the power station in the last named place. Eighty-two pound Johnson girder rail will be used throughout the entire roadbed, grading for which has been pushed vigorously. A force of five hundred men has been at work for two weeks on the roadbed, which has been cut and filled according to the best practice for steam railways, and will, when completed, be practically level. Thirteen acres of ground have been purchased in East Liverpool, on part of which a handsome red brick power station is in process of erection. Power will be furnished by two one hundred and fifty horse-power Reynolds-Corliss engines with accompaniment of two three hundred horse-power boilers and a Worthington duplex pump. Two Short multipolar slow-speed dynamos of one hundred and fifty horse-power each and a handsome marbleized slate switchboard of the latest Short type fitted with all necessary appliances for the modern electric power station will complete the equipment of the power station.

Seven twenty-six foot car bodies have been purchased of the J. G. Brill Company, Philadelphia. These will be equipped with fourteen Short "Gearless" motors, having a capacity of twenty horse-power each. The line construction will be Short system throughout.

It is expected that the road will be put in operation on Thanksgiving Day, when the citizens of the two enterprising towns have arranged to decorate their streets and cars and to give a banquet in honor of the occasion. At this writing the usually quiet streets of both East Liverpool and Wellsville are filled with foreign workmen, several hundred men being employed at different points along the line. The greatest enthusiasm has been shown from the start by the people of the two towns, the cause of their hearty co-operation being immediate relief from the steam cars, which have been their only method of communication thus far.

REED & McKIBBIN.

IT appears to be now settled beyond any question of doubt that Olean, N. Y., will soon have an electric railway system, at least along the present street car line, and probably a considerable additional line, if no unforeseen obstacles are placed in the way of proposed extensions. President Forbes, on the part of the Olean Street Railway Company, has entered into a contract with Mr. Frederick H. Reed, of Reed & McKibbin, of New York, consulting electrical engineers and electrical railway contractors, to supervise putting in the electric plant and for the construction of the road. The trolley system will be used and the equipments will be of the best. While the contract with Reed & McKibbin is contingent upon certain provisions which have not yet been definitely settled, it gives the public the gratifying assurance that the Street Railway Company is actively at work toward the speedy consummation of the enterprise and that within reasonable time Olean will have a first-class electric street car line.

NEW PROCESS RAW-HIDE COMPANY.

THIS company have recently increased their facilities three-fold through additions to their factory, and they are now therefore in better condition than ever to promptly supply the trade. The demand for noiseless raw-hide gears has been, and is, steadily on the increase, hence the addition noted above. The New Process Raw-Hide Company will be represented at the Street Railway Convention at Pittsburgh by their president, Mr. T. W. Meacham, and their secretary, Mr. A. B. Vosburgh. They will have on exhibition samples of their raw-hide pinions for all electric railway purposes.

THE WIGHTMAN ELECTRIC MANUFACTURING CO.

THE Wightman Electric Manufacturing Co., of Scranton, expect to make a good display at the convention at Pittsburgh. One of their cars will run on the Second Avenue road, and one of their trucks fully equipped will be placed on board the exhibition boat. In addition, a line of insulators and other material will be shown.

ENCOMIUMS ON THE RIKER MOTOR.

THE RIKER ELECTRIC MOTOR Co., of Brooklyn, has just received a very complimentary testimonial from J. Y. Johnston & Co., of 23 Murray street, this city, on their motor, which has been in use some six months. The firm say that they "cannot praise it too highly;" that they have "absolutely not spent a penny for repairs," and that they "will be happy to recommend it to any one wanting a motor."

NEW ENGLAND NOTES.

THE PETTINGELL ANDREWS COMPANY, of Boston, have just got out their first catalogue, embracing a full list of all general electric light and power and railway supplies. The book is handsomely bound in black cloth, and has been carefully compiled under the immediate supervison of Mr. C. B. Price, one of the members of the company. Their new P. A. wire receives first attention in the catalogue and special attention is drawn to its peculiar virtues. The book is well illustrated, and comprises almost everything required in electrical construction, amongst which may be mentioned underwriter's wire, okonite wires and cables, tapes, connectors, terminals, George Cutter's specialties, insulators, tree insulators, P. and B. compounds, hard rubber, porcelains of all shapes, wood cleats, shade-holders, reflectors, shades, a complete line of K. W. cut-outs, rosettes and sockets, Economic incandescent lamps, tools, line material, batteries, bells, the P. A. Street fixtures, switches, motors, etc., etc. The catalogue also embraces a full electric railway supply department, which the Pettingell-Andrews Company are rapidly developing. The book is well got up and makes a handsome addition to any electrical engineer's manuals of useful information.

MR. F. DAY VOORHEES, of the Norwich Insulated Wire Company, of New York, was in Boston last week attending to the wants of his friends who use paper insulation. He reports that the company is all the time pushed with orders, and are at present extremely busy equipping the old Trinidad-Heimann factory at Harrison, N. J., with a complete set of machinery for the manufacture of paper insulated wires and cables. One of the specialties which they are now introducing is a flexible magnet wire, which is both fire-proof and waterproof. They are also busy preparing to supply the trade with the old favorite Trinidad line wire, which has not been manufactured to any extent for the past few years. Trinidad used to meet with a ready sale, and no doubt Mr. Voorhees will be able to work up a good business again in this line.

WESTERN NOTES.

ARMINGTON & SIMS ENGINES.—The Pond Engineering Company report an excellent demand from their various offices for Armington & Sims engines for driving dynamos. They are now furnishing engines for the State Insane Asylum, San Antonio, Texas; Pacific Branch National Soldiers' Home, Santa Monica, Cal.; Edison General Electric Company, Traverse City, Mich.; Waterloo, Ill., Electric Light Company; Provident Life Assurance Building, Waco, Texas.

MR. CHAS. G. ARMSTRONG the well-known consulting electrical engineer of Chicago, has just started up a plant very successfully at Monticello, Ill. The plant comprises a 750-light alternator Slattery system, and a 25-light Wood arc dynamo, both manufactured by the Fort Wayne Electric Co., of Fort Wayne, Ind.

WM. BARAGWANATH & SON, manufacturers of feed-water heaters, purifiers, boilers, etc., have booked among recent orders one 200 h. p. heater for the electric light company at Tuscarawas, Ohio, one 100 h. p. heater for Westinghouse, Church Kerr & Co. and one 600 h. p. for Cedar Rapids Electric Co.

THE CHICAGO INCANDESCENT LIGHT AND WIRING CO. have opened a handsome store at 155 Franklin street, where they are carrying wiring and construction supplies. They devote themselves to burglar, fire-alarm, call-bell and electric light work, and have a large number of contracts on hand.

NEW YORK NOTES.

THE CROCKER-WHEELER MOTOR COMPANY has recently added Mr. Thomas J. Fay to its already large electrical staff. This gentleman brings with him an extensive experience gained by a previous connection with the Edison, Thomson-Houston, and other prominent electrical companies, which will be of considerable value in his present work. Mr. Fay will have charge of the testing department, the force of which the company have lately increased.

MR. C. MCLAUGHLIN, of J. H. Bunnell & Co., has become actively identified with the Central Electric Railway Co., of Paterson, N. J., and has been elected one of the directors. The road will shortly adopt electricity as a motive power, and its prospects are very bright in every respect.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

Vol. XII. OCTOBER 28, 1891. No. 182.

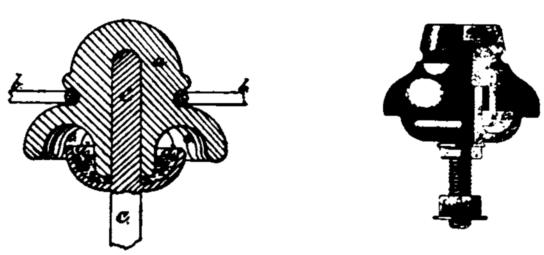
OIL INSULATION FOR HIGH-TENSION CURRENTS.

BY

Franklin Leonard Pope

THE utilization of electrical energy for the transmission of power to great distances, which in one form or another bids fair to take a position as one of the most striking achievements of modern science, can, in most cases, only be rendered commercially advantageous by the employment of very high electric potentials. The conduction of currents at high pressures in turn makes it necessary that the utmost attention should be paid to the problem of securing adequate insulation. Recently the use of liquid insulators, especially the hydrocarbon oils, has found much favor, and materials of this nature are now being used with much success, not only for subterranean and aerial electric conductors, but for transformers and other like accessory apparatus. This method of insulation has been used in the Lauffen-Frankfort transmission system, recently described in THE ELECTRICAL ENGINEER, in which a pressure as high as 18,000 volts has been dealt with, and apparently with the most satisfactory results.[1]

The discovery of the valuable properties of the hydrocarbons as non-conductors of electricity appears to have been made by the late David Brooks, of Philadelphia, who, as the result of a long series of experiments, took out a patent on Nov. 29, 1864, No. 45,221; reissue, 2,717, for a telegraphic line insulator, in which the effective non-conducting substance was paraffine, of a waxy consistency. Prior to the date of Mr. Brooks's investigations, the text books and treatises on electricity had contained no allusion to the matter, beyond classifying "oils" among conductors, accompanied in some cases with the observation that the heavier oils were the better conductors. The paraffine insulator of Mr. Brooks proved to be a very effective one, and during the next ten or fifteen years he devoted himself assiduously to the task of introducing it into practical use on the telegraph lines of America. In this he was in a considerable measure successful, although his characteristically aggressive and uncompromising advocacy of his views, and his caustic criticisms—albeit well founded—of the generally prevailing conditions of insulation upon American telegraph lines, created an inimical feeling in influential telegraphic circles, which had the effect of largely preventing the introduction of what was unquestionably an improvement of the highest practical merit. In the latter patterns of the Brooks insulator a semi-liquid form of paraffine, enclosed in an inverted blown-glass bottle, has been employed. In warm weather the hydrocarbon flows sufficiently to renew its surface, and thus for a considerable period the deleterious effect of dirt upon the insulating surfaces is avoided.



FIGS. 1 AND 2.

A subsequent inventor, Mr. W. E. Simonds, of Hartford, Conn., now United States Commissioner of Patents, obtained a patent June 29, 1869 (No. 92,111), for an insulator for aerial conductors, in which he sought to avoid the objection just mentioned. In this insulator, a section of which, reproduced from the drawings of his patent, is given in Fig. 1, the body *a* of the insulator is made of any of the ordinary non-conducting substances, such as glass or porcelain, to which the conductor *b* is secured in the usual manner. The supporting pin *c*, of malleable iron, is formed with the cup *d*, whose edge or lip projects up into a groove, *e*, formed in the under side of the insulator proper. This cup is filled with liquid paraffine or other non-conducting oil, as shown at *s*. In his specification Mr. Simonds says:

"The placing of the insulating substance in the cup, and around the extension of the insulator proper, so as to form an unbroken continuous surface from the insulator proper to the inside of the cup, over which the electricity must pass in order to escape, is a new thing, and is my invention."

We recognize here the fundamental principle of that generic type of insulator in which a liquid surface of non-conducting oil is maintained between the conductor and its support, which surface encircles the inner surface of the insulator proper, and is in a great measure protected from the influence of dust and dirt. For some reason Mr. Simonds's invention never went largely into practical use, but it may nevertheless be conjectured that, had he been an electrical engineer, a manufacturer of supplies, or an officer of a telegraph company, rather than an attorney-at-law in a provincial city, his invention would hardly have been relegated to obscurity.

Several years later the English telegraphic engineers, W. C. Johnson and S. E. Phillips, reinvented and patented an insulator substantially the same as that of Mr. Simonds, though differing in some of its details, which, having been put on the market in various forms by this enterprising and well-known firm, has met with extended acceptance. (See British patent 3,534, of Sept. 8, 1876).

In their specification the inventors say that the principle of the invention is the "introduction of a liquid insulator between the line and the earth," which may be effected in several ways. An ordinary cup-shaped insulator may be inverted, filled with the liquid, and provided with a cover to exclude the rain, or an erect bell-shaped insulator may have its lip turned up inwardly so as to contain the liquid, or, lastly, a bell-shaped insulator may have within it a cup-shaped vessel turned up outwards. The liquid to be used in all cases is by preference a hydrocarbon "which will

1. THE ELECTRICAL ENGINEER, Sept. 30, pp. 370, 371.

not support a film of moisture or dust on its surface." The accompanying illustration, Fig. 2, reproduced from *The Telegraphic Journal* of October 15, 1877, shows how nearly one of its forms resembles the one adopted by Simonds.

Most of the plants that have been established in Europe during the last few years for the transmission of electric power to considerable distances have found it necessary, or at least advantageous, to employ insulators embodying some one of the constructions pointed out in the Johnson and Phillips patent, as well as the general principle found in all these different forms suggested by them, for which principle we are indebted, in the first instance, to Mr. Simonds.

A still more recent improvement in the same line of invention, which seems likely to be of considerable importance, has just been patented by Robert J. Hewett, of St. Louis, Mo. Mr. Hewett has sought to provide for the constant and automatic renewal of a film of insulating oil, interposed between the electric conductor and the earth, so that its capacity to prevent the escape of the current cannot become impaired by exposure to dirt and moisture, even under the most unfavorable conditions, such, for example, as those affecting the conductor of an electric street railway when enclosed in an underground circuit. Mr. Hewett has ingeniously availed himself of a well-known, and often extremely troublesome property of the hydrocarbon oils, viz., their tendency to exude through minute capillary orifices in a containing vessel. One form of his

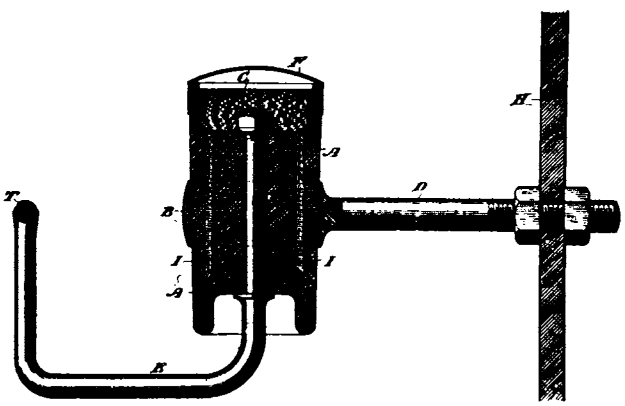


FIG. 3.

invention is shown in Fig. 3, in which the body of the insulator A is of unglazed or partially glazed porcelain or other like material, held and supported by a collar, B, having a shank, D, secured to a suitable support, H, which is shown in the figure as the wall of the conduit.

The upper portion of the insulator proper is formed into a receptacle, C, for containing a supply of liquid hydrocarbon, such as paraffine or rosin oil. The conductor T is attached to a stem or wire-holder, E, inserted in the body of the insulator.

The insulating surface is kept covered with a film of oil through the agency of ducts, I I, formed within the body of the insulator. These are kept filled from the receptacle C, and from them the oil slowly percolates through the porous material of the insulator, and flows in a thin stratum down along the external surface, dripping off at the lower edge. The non-conducting surface is thus constantly renewed with fresh oil, while any particles of dirt or conducting matter which may have lodged upon it are carried away. The receptacle C is covered with a cap, F, which may be removed when fresh oil is supplied.

Mr. Hewett's invention would seem to possess a peculiar value for underground conduit work, although it can hardly fail to find also extended application in the construction of lines of high insulation for long-distance power transmission.

In the Lauffen-Frankfort plant, the transformers have also been effectively insulated by the application of oil, in which the transformer is immersed.[1] The credit of this idea seems to be also due in the first instance to Mr. Brooks. Of course, a transformer is nothing more or less than a mammoth induction coil, and the difficulties which arise in the insulation of the transformer are of the same character as those which have always been met with in the insulation of the induction coil. Mr. Brooks obtained a patent on December 17, 1878, in which he claimed as his invention a method of insulating induction coils or bobbins of wire of other electrical instruments, which consists in immersing them in a liquid insulating substance, by preference paraffine oil. It was while experimenting in connection with this invention that Mr. Brooks made the singular discovery that paraffine oil offers even a higher resistance than dry air to the passage of the electric spark.

Space does not admit more than a mere mention of the application of liquid insulation to subterranean and submarine conductors, another conception of the fertile mind of Mr. Brooks, which has proved to be of importance and value. But the increasing attention which is now being paid to the utility of this method of insulation for many purposes has suggested that it is due to the memory of Mr. Brooks and other early workers in this field that their labors should receive due recognition.

ECONOMY IN ELECTRIC POWER DISTRIBUTION.

BY

J. Stanford Brown.

I REGRET that Mr. Leonard thinks the purpose of my note in THE ELECTRICAL ENGINEER (XII, No. 179, p. 397, of October 7, 1891) was an endeavor to show an error in his work.

His formulæ and deductions are certainly in a form to which many are unaccustomed, and by such have to be translated, so to speak, in order to get at their full purport.

Now the questions involved in the problem under consideration are certainly of vital importance, from an engineering point of view, and while Mr. Leonard has provided an elaborate paper, he has not, unfortunately, taken up the matter step by step and shown just how and where previous "authorities" went astray, and by figuring in K. Ws., instead of in H. P., has rendered comparison of his results with those of other writers more difficult.

That Mr. Leonard's formulæ referred to electric "power at the terminals of the translating device," instead of to "mechanical power at the pulley of the motor," as in Sprague's formula, was just the point requiring emphasis to show that these gentlemen did not argue from the same standpoint.

Mr. Leonard denies that the factor "1,000" has any relation to H. P., but does not explain its presence. It has been suggested that he has figured in "K. Ws. per 1,000 feet transmission," although such fact is nowhere apparent in the original article.

That Mr. Leonard did not make the motor efficiency a factor was evident; but supposing one wishes to get 100 h. p. out of a motor of 90 per cent. efficiency, should the wire be figured for minimum first cost CONSISTENT WITH maximum economy by the use of his formulæ and then 111 per cent. of the circular millage so arrived at be taken, or should the calculation be made to deliver 111 h. p. at the motor terminals? If the formulæ are not to be applied in either of the above ways, what is the proper mode of procedure?

Since Mr. Leonard's formulæ (E. E., XII, No. 180, p. 436, October 14, 1891) "were intentionally put in such shape

1. THE ELECTRICAL ENGINEER, Sept. 30, p. 370, Oct. 7, p. 399.

as to apply whether the energy be used for motors, incandescent lamps, etc., etc., " is it to be inferred that while the translating-device efficiency can be omitted in the case of motors, it must be taken into account in lighting, heating, etc., and if so, why can it be omitted in the former case? Any further comment upon the contents of Mr. Leonard's very interesting paper will, I trust, be taken by him and by "the electrical public" solely as an endeavor to evolve the true laws of economical distribution.

THE EFFECT OF ELECTRIC LIGHT ON PLANTS.

BY

Chas. Steinmetz.

With great interest I read in The Electrical Engineer of Oct. 14, the report on the experiments, undertaken at Cornell University, with regard to the determination of the influence of electric light on plant life. As I understand these experiments, there seem to be two distinct actions of the electric light upon living plants.

1. It increases their vitality. This is shown by the hastening of maturity, the early blooming before being in full leaf, and also the slender form.

2. It acts destructively upon leaves and flowers. The curling of leaves and the fading of flowers point to this influence, which might be, perhaps, a purely chemical action.

The first action will, in very many cases, be useful for agriculture; sometimes even of such great value as to be quite out of proportion to the cost of the light. For instance, if a wine crop, which otherwise would be a failure, could be made to ripen in time by the application of electric lights for a few weeks, this would sometimes save an immense amount of money. Hence I should consider it worth while to try whether these two actions of the light could not be separated, the latter one suppressed and only the former one retained.

Plants being especially acted upon by the long light waves at the red end of the spectrum, the increased vitality may be caused by these long waves of the electric light, while the fading of the colors, etc., seems to attribute the destructive action to the short actinic waves at the violet end of the spectrum, which are proportionally more intense in the electric arc than in the sunlight.

Hence I should suggest a repetition of these experiments, *blinding off* the *actinic rays* either partly or wholly to determine whether, in this way, the increase of vitality of plant life could not be got without the destructive action, while it would be interesting also to blind off only the long waves and leave the actinic rays, to determine by those plants which proved to stand the electric light best, whether an increase of vitality is still perceptible.

Incandescent light, which is rather poor in actinic rays, could be tried instead of the arc light, and should give only the first action, if this reasoning be true, and these different actions of the electric light are due to different parts of the spectrum. I should think it of great importance for agriculture to determine this, and well worth the while of an institution which has done so much already in solving electrical problems.

DISCOVERY OF MICA DEPOSITS.

A discovery of large quantities of mica is said to have been made at a point about twenty-five miles west of Muldiva, Australia. The plates, it is reported, are of fairly good quality, improving as the development proceeds, and are free from impurities. Four leases have been applied for, comprising an area of 100 acres.

WEIGHTS OF ELECTRIC CARS ON BRIDGES.

Several electrical engineers have had lately to deal with questions arising from the increased load that ordinary highway bridges have to carry on account of the passage over them of electric cars. The repair or strengthening of such bridges to withstand these loads is calling for a considerable amount of engineering work at the present time, but so far as we are aware nothing has appeared in print on the subject. Mr. Oscar T. Crosby has favored us with the following in reply to an inquiry addressed to us:

"The weights imposed upon bridges by electric cars may be considered in two ways,—first, as to the maximum weight per running foot, and second, as to the total weight irrespective of length.

"In regard to the first, the maximum may fairly be taken as the weight of a heavily loaded eighteen-foot car standing on a six-foot wheel base. The maximum total weight in such case may be taken at 25,000 lbs., of which 12,500 would then pass through each end of the wheel base, or 6,250 through each wheel. While this total weight of 25,000 lbs. is thus concentrated, or may be concentrated, within a distance of six feet measured along the distance of the bridge, yet of course the overhang of the car would make it impossible that any other weight should fall directly over the length covered by the car in question. Looking at it in this way it would therefore appear that 25,000 lbs. over a distance of about twenty feet would be about the maximum given by present practice. It may be that the use of separate locomotives would increase this as follows: A locomotive having, say, a six-foot wheel base will be followed immediately by a heavy car, either single truck or double truck. The worst case would appear to be when the locomotive is followed directly by a double-truck car.

"Let us suppose the total length of the locomotive does not exceed eight feet, which would be an overhang of one foot beyond each end of the six-foot wheel base. Further suppose, in order to get the limiting case, that the car has no front platform, but is coupled directly up to the engine, when the wheel base of this forward truck would fall within, say, a distance of ten feet measured to the rear from the end of the locomotive, or otherwise expressed; we should have distributed over a distance of seventeen feet, the total weight of the locomotive and half the weight of the car. The weight of the locomotive can only be approximately given now since there is no example of practical use before us. The uncertain factor in the case lies in this, that we do not know what weight of train will finally be attempted for street railway service. My own opinion is that a train of length equal to three sixteen-foot cars represents the limit which municipal governments will permit for the length of a single unbroken train. The weight of three such cars would be, say, 75,000 lbs. For such grades as would be attempted with such a train, the weight of the locomotive need not be greater than one-third of the weight to be hauled; this relation of course having to do with the required adhesion. We should then have 25,000 lbs. as the weight of the locomotive resting by supposition on a six-foot wheel base. The maximum weight resting on one truck of the double-truck car, say thirty feet in length, may be taken at 20,000 lbs., giving a total of 45,000 lbs. distributed over seventeen feet measured along the axis of the bridge. This we should consider about as far as we need figure for anything that may properly be called street railway pratice.

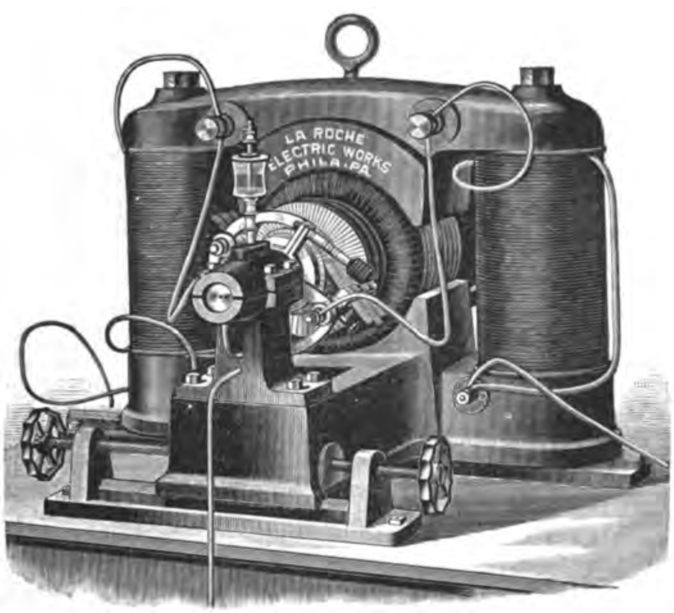
"As to the total weight that may go upon the bridge, it is probable that 100,000 lbs., made up as stated above by three sixteen-foot cars and one locomotive, will be the maximum for anything except elevated or underground service. In order that the bridge should receive the whole of this weight it must of course have a length equal to that of the cars plus the locomotive.

"If your correspondent has in mind the ultimate weights that electric locomotives will finally impose on bridges, that of course is another story. In the end we will be doing work of equal magnitude to that now performed by the largest steam locomotives. That character of work is not properly called street railway service."

THE LA ROCHE ARC LIGHTING DYNAMO.

We published recently an article on the La Roche system of electric lighting, with particular reference to the incandescent machine. We now illustrate Mr. La Roche's arc dynamo, which is built for 50 lights of full standard 2,000 c. p., at his works in Philadelphia. During the present year there has been an active demand for these machines, and one of them now running over three months with a load of 50 lights is pronounced a remarkable success. A test recently made with a machine carrying a circuit of nearly 40 lights showed that the number could be instantly cut down to even one light without an indication of variation of current in the lamp. Close regulation of this kind is a most desirable feature.

The armature is of simple construction, being built up of annealed iron wire as a core, and allowing of very free air circulation, so as to run perfectly cool. It has only 70



La Roche Arc Dynamo.

pounds of copper wire wound on it, and is run at a speed of 750 revolutions a minute. The running is extremely smooth, and gives no sign that the machine is doing work.

This dynamo, whose peculiarities of construction show very plainly in the illustration, has an insulating base, fitted with self-oiling bearings. It has also an excellent automatic adjustable brush holder. Carbon brushes are used, so that wear of the commutator is practically eliminated, and there is no sparking.

So well pleased is Mr. La Roche with this type, and so satisfactory has it proved, he is now building a 150-lighter to fill an order from Australia. This dynamo when finished will be one of the largest arc machines, if not the largest, in the world.

UTILIZING THE RHINE.

A syndicate of Swiss and English capitalists, it is stated, has been formed to utilize a part of the Rhine Falls at Lauffenburg for the generation of electric energy. The water will be led off to turbines by races of $\frac{3}{4}$ mile long, and will yield a total of 7,000 h. p.

THE LOCALIZATION AND REMEDY OF TROUBLES IN DYNAMOS OR MOTORS.—VI.

(Copyright.)

BY

Francis B. Crocker and S. S. Wheeler.

SPEED TOO HIGH OR LOW.

This kind of trouble in either dynamo or motor is a serious matter, and it is always desirable, and generally imperative, to shut off the current immediately and make a careful investigation of the trouble.

1. Cause.—*Overload.* (See Sparking, No. 1.)

Symptom.—Armature runs slower than usual. Bad sparking at commutator. Ammeter indicates excessive current. Armature or bearings heat. Belt very tight on tension side.

REMEDY.—Reduce the load on machine by taking off lamps in the case of a dynamo, or mechanical work in the case of a motor; decrease the diameter of driving pulley or increase the diameter of driven pulley.

2. Cause.—*Short circuit in armature.*

Symptom and remedy same as Heating of Armature, No. 2.

3. Cause.—*Armature runs slowly because it strikes pole-pieces.* Symptom and Remedy the same as Noise, No. 2.

4. Cause.—*Armature runs slowly because its shaft does not revolve freely in the bearings.*

Symptom.—Armature turns hard by hand; bearings and shaft heat when running.

REMEDY—Oil the bearings; clean and smooth, if necessary, the shaft and bearings; line up the bearings. See Heating of Bearings, all cases.

5. Cause.—*Field magnetism weak.*

This has the effect of making a motor run too fast or too slow, or in some cases even run backwards, but makes a dynamo fail to "build up" or excite its field and give the proper voltage.

Symptom and Remedy the same as Sparking, No. 7.

ATMOSPHERIC ELECTRICITY.

The most important recent experiment regarding atmospheric electricity in England, carried out by Mr. Alexander McAdie, seems to take one back to the very infancy of electrical science; for, though the conditions were somewhat different, the operation was substantially identical with Benjamin Franklin's historical experiment with the kite. What Mr. McAdie has demonstrated is that electricity can be drawn from a kite high in the air in a cloudless sky. The kite, Mr. McAdie states, discharged sparks from the lower end of an insulating wire reaching down to the earth, where an electrometer partly measured the increasing electric force. So nearly did the quantity of electricity in the upper air correspond to the height of the kite above the earth that the experimenter could usually determine whether the kite was rising or falling by simply looking at the needle of the electrometer.

THE DEPENDENT—OVERHEAD OR UNDERGROUND—SYSTEM OF ELECTRIC MOTIVE POWER.[1]

BY GEO. W. MANSFIELD.

FIRST, THE UNDERGROUND METHOD.

UNDER this heading I have classified all methods of conducting or transmitting electricity to the car by means of any conductors or devices placed underground. I might possibly divide into two classes: First, continuous bare conductors placed in an open slotted conduit; and second, all other devices of automatic character which enable the contact piece or device on the car to take its electric current from sectional bare conductor or from bare metallic points, automatically made alive. There have been in this country at least four practical experiments with the first-class, several hundred thousand dollars have been expended in testing it, and thousands additional in perfecting it, particular attention being given to the protection and insulation of the bare conductor. In spite, however, of all this refinement and study, practically nothing has been accomplished, and I have no hesitation in asserting that the continuous live conductor in an open slotted conduit is to-day a failure and that it cannot be made a success throughout our cities of to-day, its fatal weakness being our inability to prevent the conduit from becoming filled with water, mud, etc.

No large practical experiments have been made with this second class, but a large number of patents have been issued, and evidently there has been a great deal of careful thought and study bestowed upon it. I, however, have no hesitancy in asserting that this class also will never prove a success, nor can it be made to work successfully throughout any of our cities to-day. The reason for this is obvious. It is immaterial whether the automatic devices prevent the sections of contact points from being alive all of the time or not; if the conduit is filled with water or mud, and the points are made alive just as the car passes, there is bound to be a momentary grounding from these points. In other words, a point made alive in water with the other side of the circuit grounded is just about as dangerous and bad as if it remained alive. It is true that the grounding may not be as severe, but still it will occur, and with a large number of cars throughout the city moving at the same time, causing therefore a large number of points to be alive, if any number of points were grounded through water, it would cause a tremendous loss upon the central power station, and in all probability a complete grounding or short-circuiting of the entire system. Numerous ingenious schemes have been devised to overcome this fatal weakness. None, however, have ever been put to trial. I have seen many, yet to-day there is no hope in this direction.

SECOND, OR SURFACE METHOD.

The inventions covered by this method are somewhat similar to those employed in the conduit system, only in place of being in a conduit, they are placed upon the surface of the street. By far, however, the larger number of arrangements are based upon what might be called the "Interval" or "Point" system. Primarily, this arrangement consists of an underground insulated conductor connected by means of taps to contact points on the surface of the ground, held in place by means of iron boxes, and insulated therefrom by means of rubber, wood, fibre or other similar substance. Upon the car is swung a long contact plate, extending practically from one end to the other. This plate is carried close to the ground, and is arranged to touch the points as it passes along. It is plainly apparent that if these contact points are always alive, then every time the street is covered with water short circuits are inevitable. To overcome this, many automatic arrangements have been devised to cut these contact points into circuit by the car as it passes along. All these arrangements have the same fatal weakness—a liability to ground or short circuit. I do not consider any of them practically possible. There is one system, however which obviates many of the objections. The inventor has a slot between his rails, and boxes with a contact device within, placed at proper intervals. Upon his car is a plow which passes along through the slot, and also a long contact plate or arrangement extending its entire length. The operation of the invention is as follows: The plow as it passes through the slot strikes a lever placed in connection with each box, which lifts for a distance of six or eight inches above the ground a piston carrying the contact piece proper. This is made in the shape of a right-angle hook placed within a vertically moving piston, and thoroughly insulated from it. As this is raised up, the long contact plate under the car passes beneath the hook and holds its up. The current is taken into the car as the plate slides along under the live hook.

Naturally, as the car passes along, the hook slides off from the end of the contact bar and drops back into place. To protect this hook, or contact piece proper, it is covered by an extension of the cylinder, so that, as far as the street is concerned, the surface is perfectly smooth, and one sees nothing but a small round cover in the centre of each of these boxes. The contact hook is alive only when it is resting on the contact plate of the car. Certainly, in so far as getting rid of all the troubles due to the street being covered with water, this is successful. The fatal weakness whereby the contact points remain permanently on the street surface is obviated here by the contact point being practically lifted six or eight inches above the surface. In regard to the permanence and reliability of this system, I can say nothing, as no trials have been made. The inventor claims to have overcome every objection.

Summing up the general results of the underground and surface methods, it certainly looks as if we could not expect very much from them in the immediate future. Our rival is the cable. It certainly does look as if for the enormous sums they expend in making their system feasible we ought, for an equal sum, to make ours perfect. Mechanically it is an assured success, but electrically it has not so proved.

Is it not possible for some bright inventor to devise a scheme whereby the insulation of the live parts can be maintained? This is the sum of all the difficulties. A simple transposition of parts and the problem may be solved.

THIRD, OR OVERHEAD METHOD.

There are two general methods of operating the overhead system. One is by having a continuous trolley wire, and the second is to have this trolley wire divided into sections. For towns and for suburban traffic, the former is almost invariably adopted and carried out. Practice would seem to indicate that but little trouble is experienced, and that there is practically no advantage in dividing the trolley wire into sections. In fact, a disadvantage, since you lose its conductive capacity.

The sectional trolley wire surely must be used for all city work. It is, however, almost impossible to originally fix all of the divisions once for all. It is bound to be a gradual growth to a large extent.

Obviously the methods of feeding the trolley wire vary with the method of arranging the trolley wire. With the first method mentioned (using a continuous trolley wire) the feeders are either extended from the station the entire length of the line, tapping into the line at intervals, or else separate feeders are run out from the station to certain predetermined distances, and there tapped into the trolley wire. When more than one feeder wire is needed in either case a repetition of the scheme is carried out from feeder wire to feeder wire. There is little to choose between the two methods. Both are good.

With the second method (the divided trolley wire) there are two ways of accomplishing the feeding. First, to extend a feeder the entire length of the line and tap into the centre of each section of trolley wire; or second, to extend the feeder the entire length of the line and tap into both ends of each section. The advantages of the former are, that in time of trouble a man has to run to only one box to cut out a section, or the whole arrangement could be made automatic by putting a fuse or mechanical circuit breaker in the box. The disadvantage is that you lose the value of the trolley wire as a conducting medium, which in the case of hard drawn copper wire is considerable.

It is undeniably true that the question of feeder wires is one of great importance and a difficult one to always economically solve for all conditions. The point, however, which the railroad corporations should watch above all others is that they have enough. I have visited many roads where I found that the larger part of the trouble which they were complaining of lay in the fact that they did not have either sufficent trolley wire or track feeders.

I strongly recommend as many ground plates as it is possible to have, not only at the station, but also along the line. The plates can be made of sheet-copper or iron, preferably the latter, and should have a superficial area of several hundred square feet. The wire connecting them to the track should be of sufficient size and very solidly attached to the plate and the rails. The continuous supplementary wire should in all instances be employed, and the rails bonded at least once. In no instance do I think it necessary or wise to place the track feeders overhead. If this plan is adopted and carried out, and proper connections are made between the rails, I do not think the railroad companies will ever have any trouble with loss of power on their ground circuits.

Referring again to the overhead feeder system, I am strongly of the opinion that for large cities all feeders should be placed underground. The cities in which this underground work has been adopted are Buffalo, Minneapolis and St. Paul. I cry, all praise to the courage of these railway corporations.

I contend, however, that whenever anything can be done to advance the interests of the overhead system, it should be done. Now, will it not be materially assisting if you, when you go before your local municipal board and the public, petition for only the trolley wires, agreeing to place all other wires underground?

The construction work can be done simultaneously with the

1. Abstract of a paper read before the American Street Railway Association, at Pittsburgh, Oct. 21 1891.

track reconstruction, for it is my experience that whenever a large city railway adopts electric power it is almost absolutely necessary to rebuild its tracks. Under these circumstances I doubt if the cost of the conduits or ducts would be more than a few thousand dollars additional per mile.

In regard to the overhead devices and material used, I can only urge the advice that the most substantial and perfect apparatus that can be secured be used. Too much care and attention cannot be bestowed upon these devices. It is also well to consider the question of uniformity in the apparatus. The only part that is liable to deterioration is the insulating material. Make this, therefore, of a uniform pattern and arrange the various holders for its reception. With such a system nothing can fall, and the insulation can be maintained easily and perfectly. It would be like renewing a glass insulator on a telegraph pole.

I come now to the discussion of the answers to the forty questions I asked by circular letter.

Out of the 400 and odd circulars I sent out, some, however, being duplicates, I succeeded in getting answers from 137 roads, operating 1,546 miles of trolley wire and 1,657 motor cars. Of this number 71 were Thomson-Houston and 66 Edison or miscellaneous. For the sake of convenience I have divided the various questions into the following topics: 1. Trolley wire. 2. Span and guard wires. 3. Feed wires. 4. Loads carried and conditions. 5. Tests. 6. Accidents. 7. Miscellaneous.

First. The trolley wire: Of the 137 roads, 99 were using copper wire, 28 silicon bronze wire, 8 were using both, and 2 were using phosphor bronze.

Of those using copper, one used No. 000; 5 No. 00; 3 No. 1; 2 No. 2; one No. 5 hard drawn copper; one used No. 0 soft drawn copper, making 13 in all, and leaving 86 as the number using No. 0 hard drawn copper wire.

Of the 28 using silicon bronze, 16 used No. 4; 6 No. 2; one No. 3, and the five remaining roads had combinations of two or more sizes.

Of the 8 using both silicon bronze and hard drawn copper 6 prefer the latter.

Out of all these 99 using copper not one dissents, but of the 28 using silicon bronze 11 advise copper. The proof is conclusively in favor of hard drawn copper wire and of the larger sizes, No. 0 B. & S. seeming to be the standard.

In regard to the wearing, the universal testimony is that it is exceedingly slight. What wearing is observable is found to be at the switches or on the curves.

Serious mistakes have been made in the past by using iron flanged trolley wheels. These cut the trolley wire badly. Everything should be done to throw all the wear on to the trolley wheels.

It would seem that with the ordinary brass trolley wheel the wear was about .001 of an inch to the passage of 65,000 cars. This is at the rate of one in every six minutes, for eighteen hours per day, for one year. With only this wear the life of the wire would certainly be twenty years, unless through some process of crystallization it became more brittle. Undoubtedly, at curves and on switches the wear is somewhat greater.

The breaking of the trolley wire has been rare, the breaks occurring either at splices, or switches, or being due to some extraneous cause. In no instance was any casualty reported, excepting in one case where a mule was killed.

Forty-one roads have their trolley wires divided into sections, and consider it necessary and advisable. Analysis shows that these roads are in the largest cities or towns.

Second. Regarding span wires, 49 report as using galvanized iron wire, 55 as galvanized steel, 20 as using galvanized iron cable and one as using copper wire. The sizes range from No. 0 to No. 14. Comparatively few breaks and no casualties are reported.

My own experience has led me to adopt No. 4 B. & S. soft galvanized iron wire. Whenever a long span or a curve is to be constructed I have had two or more of these wires twisted together into a cable.

	Diam.	Breaking weight.	Breaking weight per square inch.	Elongation in six feet.	Twists in six feet.
No. 1 silicon bronze..	.200	2,550	81,800	.8 per cent.	37.4
Galvanized iron......	.205	1,720	52,000	7.8 per cent.	19

I have found that a cable made of small wires is hard to joint, and it rusts much more quickly. Avoid joints, and use a ball fastener in attaching span wire to eyebolt. On the whole, however, I have concluded that iron is not the proper material to use in any shape. It will rust, and then your structure is weak. Pursuing my investigations into this matter nearly a year ago, I found that a certain special quality of silicon bronze wire was the best. Tests of this wire in comparison with iron showed the results given in the preceding table.

I am aware that the price of this wire is five or six times as great as that of the iron wire, but as the total sum in either case per mile is small, I strongly recommend it. Some of this wire has been in service on the West End road, in Boston, for nearly a year. It certainly will never rust out. Guard wires are universally condemned, but are put up as a compulsory protection from existing evils.

Third. The descriptions of the various feeder systems are so vague I will not attempt to describe them. The average distance to which power is transmitted on these roads is about three miles. The greatest is 10.7 miles on the Tacoma & Steilacoom Railway, Tacoma, Wash. There are many, however, operating from eight to ten miles from the station.

Fourth. Loads and conditions: Under this heading I have included speeds, grades, number of tow cars hauled, passengers carried, etc. The average speed of all the roads is 8.7 miles per hour. The maximum is thirty. The average grade is 6.7 per cent., and but 12 roads report as having none, or very small ones. The maximum grade is 13¼ per cent., and this extends for 1,500 feet. The road suffering from such an infliction is in Amsterdam, N. Y. Thirteen roads report 10 per cent. or over. Nashville, Tenn., reports an 11¼ per cent. grade for 1,300 ft., and Burlington, Iowa, an 8¼ per cent. for 1,500 ft., while Wilmington, Del., reports a 7¼ per cent. for 3,000 feet.

The loads carried up these grades by two 15 h. p. motors are, to say the least, surprising. Amsterdam reports one motor car and fifty-two passengers. Nashville reports one motor car and seventy-seven grown passengers. Burlington, one motor car and seventy five passengers, and Wilmington, Del., reports one motor car towing a disabled motor. Several roads report as towing one car with both full of passengers up to eight and even nine per cent. grades, but for short distances. Auburn, N. Y., reports as having towed five cars all loaded with one motor car. The grades in this instance were slight. In all these instances unquestionably the motors were exerting power considerably beyond their rated capacity. Trains carrying 350 passengers have been moved by two 15 h. p. motors; 200 passengers is an every-day occurrence. Surely this is approaching steam railroad practice. Such information is certainly useful to the electric manufacturing companies.

Fifth. Tests: Out of the total number of 137 roads heard from, only 32 report as having made any tests of either engines, dynamo or motors, and 53 upon the overhead work. Surely this is lamentable. There is nothing more essential to an electric railroad than a first-class voltmeter, ammeter, galvanometer, and, if possible, a wattmeter. Electric light, telegraph and telephone, and all other electric companies are supplied with necessary testing instruments, and in most instances a most rigid system is maintained. Every railroad should be continually testing its circuits, station and cars for leaks or grounds. By this means, and this means only, can they avoid trouble and consequent damage. Furthermore, for the sake of economy these instruments should be used freely. Particularly is a wattmeter useful in power stations. I advise, urge and beseech every company to supply itself with these instruments, and to put them in the hands of a competent person, or if they can afford it, a thorough electrician.

Sixth. Accidents: I am happy to state that under this heading not one road reports as killed or even seriously injured an employee or passenger by the electric current, or falling trolley or span wire. Several report employees as receiving shocks, and one of a boy throwing a wire over the trolley wire and receiving the full potential of the current. None, however, were seriously injured. Several accidents are reported of collision and running over, but these cannot be entirely avoided, and are inherent in any system.

Miscellaneous: Under this heading I asked the opinion of the railroads as to the reliability, permanency, and safety of the electric system. All but one report most emphatically in its praise. I regret very much that this one prefers horses. Further evidence on this point is shown by the fact that 44 roads report as never having been stopped by any cause, 23 were forced to stop because of the steam plant, failure of water, floods or fire, and 26 from electrical troubles, the main cause of these troubles being lightning. I consider this a very fair showing, and feel confident that as the art advances, these tie-ups will grow less and less, and finally become of rare occurrence.

I have now briefly reviewed the Dependent System, or, as I should have preferred to call it, the Direct System. There are some grounds for hope in the direction of an underground or surface system. There is universal praise and encomium sounding on every side for the overhead system; 6,700 cars operated on 3,000 miles of track in the streets of fully 300 of our towns and cities, surely testify to its merits and value. Of this number of towns and cities fully one-third have absolutely no other means of transportation. What objections there are are purely sentimental grounds. Given a city with all wires underground, where would be the objection to iron poles and a single wire for each track? The rails themselves would be a thousand times more of a nuisance and dangerous. The benefits to come from its introduction are incalculable. In the words of Parnell, "Hold on, fight on. A magnificent future is before you" The wonderful and marvelous development of the past is not to stop, but inevitably must continue. Electric railroading, city, town, and suburban, is here for our upbuilding and natural prosperity as surely as steam railroading was fifty years ago. There are equally great opportunities for fame and fortune with this new agent as with the old. Let there be no uncertainty, no hesitancy.

ELECTRICITY THE MOST ECONOMICAL POWER FOR STREET RAILWAYS.[1]

BY J. S. BADGER.

THE elements which enter into a consideration of the questions at issue, are: First cost of road and equipment; operating expenses per passenger carried; ratio of operating expenses to receipt; and operating expenses per car mile.

Upon the first and the last must rest the decision as to what is the most economical power for street railways.

The element of first cost may or may not decide the question at once. If the capital available is limited to the amount necessary for the least expensive construction and equipment, this settles the question of choice of motive power. If the capital is limited only by the ability of the road to pay a reasonable return upon the investment, the question becomes more complex; and whether a cheap or expensive construction shall be adopted depends upon whether the interest charge added to cost of operation will be large or small when divided by the total number of units of comparison.

Cost per car mile, for cars of about equal carrying capacity, seems to be at present the only basis of comparison. This expense, within the limits of traffic for which the power plant and equipment are adapted, remains pretty constant regardless of variations in amount of traffic, but this is directly affected by change in value in any item of operating expense just to the extent that such variation is part of the whole expense.

A careful examination of the roads in question shows the incorrectness of the statement that those "which have the least expense per car mile have the greatest expense per passenger carried." There is no uniformity in this respect one way or the other, as between different roads. Theoretically, the expense per car mile would slightly increase with an increase in traffic. In a general way, and without attempting to produce any proof in support of this opinion, it may be said that, other conditions remaining the same, the expense per car mile would increase about as the cube foot of the number of passengers carried. In this way, and under conditions seldom realized in practice, the foregoing statement might be true.

While the manufacturing companies may have been guilty of sins of omission, the *operating* companies have been guilty of sins of omission and commission. Experience has been costly for both. Electrical apparatus must have intelligent care, or the repair bills soon assume large proportions, and this frequently causes railway companies, who do not understand the true cause of the trouble, to condemn electricity as an expensive motive power. What can be and is actually accomplished in practice is shown elsewhere in this paper; and it is not too much to say that there are few roads, operating under the Edison system, that cannot at least closely approach the average of the "Seven Representative Roads," referred to in the tables which are given herewith.

The item of first cost is the subject of considerable discussion. Direct information concerning cable roads has not been obtainable; but as the figures we cite are those given by the Census Department, and do not seem to have been questioned by any authority upon the subject, they may accepted as substantially correct. Our data concerning horse roads, being taken from sworn reports to the Massachusetts Board of Railroad Commissioners, can also be relied upon. The figures given concerning investment in electric roads have come from official sources, and are confirmed by private information. These are, however, excessive. Most of the roads mentioned were formerly horse roads, and to the original investment has been added the cost of change of motive power; and in almost every case the amount now charged to permanent investment is far in excess of what it would cost to renew the entire power plant, track and equipment.

An attempt has been made to show that electric roads cost nearly as much as cable roads for equal class of construction. As to how much a company might, for purposes of its own, or through mistaken ideas, see fit to invest, it is not necessary here to discuss; but as to how much is necessary for first-class construction, there is little question. One of the foremost roads, with an equipment first-class in every respect, has a permanent investment, including paving, almost exactly that given as the average in Table I.

Estimates upon track construction differ greatly, but the limit of profitable investment is not likely to exceed $10,000 per mile; while as fine and substantial a roadbed as electric car ever ran over was built at a cost, exclusive of paving, of about $5,000 per mile.

Seven Representative Roads, Operated Entirely by Electricity.

Road.	Length. Of all tracks.	Length. Of road.	Passengers carried annually per mile of road	Number of cars in daily operation.	Average daily mileage per car.	Average number of passengers daily per car.	Passengers carried per car mile.	Operating expenses per car mile.	Operating expenses per car per day.	Cost per passenger carried.
1	51.0	35.0	*162,857	50	100	318	3.13	12.29	12.29	3.93
2	40.0	19.5	487,582	140	91	188	2.06	7.80	7.10	3.79
3	16.0	10.0	199,000	16	125	348	2.75	8.43	10.54	3.07
4	8.5	5.0	*460,000	20	83	318	3.82	11.82	9.80	3.09
5	15.5	14.0	167,511	18	106	357	3.35	11.00	11.70	3.28
6	28.0	23.5	286,852	81	108	597	5.51	12 74	13.76	2.31
7	3.8	2.8	200,000	5	92	307	3.33	8.49	7.81	2.55
	162.8	109.8		280				9.83		3.28

*Estimated.

Total annual car mileage, 9,862,000. Total number of passengers carried annually, 29,144,000.

The overhead structure need not cost to exceed $2,500 to $3,000 per mile of single track for best wood poles, or $3,500 to $5,000 for iron poles. For double track, iron poles, it would vary from $4,500 to $6,500 per mile, centre pole construction being the cheaper and in many other respects preferable where it can be adopted.

$3,000 to $3,500 per car is a liberal estimate for 16-foot to 20-foot cars, fully equipped, and the average is about two cars per mile of road.

An allowance of 15 to 20 h. p. per car, at $80 to $100 per h. p., for station equipment, including steam plant, but not real estate or buildings, is very liberal.

Thus we have, as an extremely liberal estimate, $26,000 per mile, exclusive of real estate, buildings and paving, for a road suitable for the heaviest metropolitan traffic. And it is a fact that a good and satisfactory road can be built and equipped for $20,000 per mile.

Table I. shows that, taking street length as the unit of comparison, in the cases of the roads under consideration, the total permanent investment of the electric roads is only 15 per cent. more than that of the horse roads, while the cable roads cost more than nine times as much as the electric roads. The average speed of cable and of electric cars is about the same, consequently the cable roads ran about four times as many cars per mile of street length as the electric. This would be expected, as the cable roads generally occupy the routes of heaviest travel. The horse roads ran more cars than the electric, for an equal length of road, but the latter having an advantage in higher speed, greatly exceed in

1. Abstract of data prepared for the American Street Railway Convention, Oct. 21, 1891.

car miles run. The electric roads carried fewest passengers per car mile, but carried nearly as many per mile of street occupied as the horse roads. On account of their more favorable location, the cable roads exceed both the others in passengers per mile of route. The column showing passengers carried per mile run gives a general idea of the relative number of passengers on a car at any one time.

Table II. shows operating expenses per car mile, all taxes and fixed charges excluded, for each of the three systems; interest charge per car mile at 6 per cent. upon the total permanent investment; total of operating expenses and interest, per car mile; cost per passenger carried, interest charge excluded, and the same with interest charge included. Upon every point, save the one unimportant one of cost per passenger carried (interest excluded), the superiority of the electric road is plainly evident.

Comparison of Investment and Operating Expenses.

TABLE I.

	Total investment real estate road and equipment.		Car miles run per annum, per mile of street length.	Passengers carried annually per mile of street length.	Passengers carried per car mile run.
	Per mile of street length.	Per mile of track length.			
*22 Electric roads..	38,500	27,780	76,158	237,098	3.10
†45 Horse roads.....	38,406	31,098	43,345	251,816	5.89
‡10 cable roads......	350,396	184,275	309,395	1,355,965	4.38

TABLE II.

	Operating expenses per car mile run. (Cents.)	Interest charge per car mile at 6% on total investment. (Cents.)	Total of operating expenses and interest, per car mile. (Cents.)	Cost per passenger carried, interest excluded. (Cents.)	Cost per passenger carried, interest included. (Cents.)
Electric roads.....	11.02	3 03	14.05	3.55	4.53
Horse roads.......	24.32	4.62	26.94	4.18	4.98
Cable roads........	14.12	6.97	20.91	3.22	4.77

TABLE III.

	Ratio of Investment, per mile of street length.	Ratio of car miles run annually per mile of street length.	Ratio of cost of operation per car mile, interest included.	Proportional traffic that must be done, per mile of street occupied, to pay operating expenses and 6 % on the investment.
Electric roads.	1.152	1.757	.485	.852
Horse roads.	1.000	1.000	1.000	1.000
Cable roads.	10 486	7.138	.722	5.154

* Car miles run per annum, 14,013.187; passengers carried per annum, 43,614,-973; street length, 184 miles; track length, 255 miles.

† All the roads in Massachusetts operated exclusively by horses for 1885–90. Average for six years.

‡ From Census Bulletin No. 55.

Table III. for greater convenience in comparison, shows the ratios of the three most important items, and the proportional traffic that must be done, per mile of street occupied, for each system, to pay operating expenses and 6 per cent. on the investment. Here, more than anywhere else, the superiority of the electric road is plainly evident, the last column showing that in but few cases can there be even a question as to which system offers the greatest inducement to the investor.

If the electric roads carried as many passengers per car mile run as the horse or cable roads, which they could easily do, and allowing for the increase in operating expenses due to increased traffic, the cost per passenger carried would be as follows:

	PER PASSENGER.
At 5.81 passengers per car mile (number carried by horse roads), the cost would be, interest charge excluded..........	2.38 cents.
At 5.81 passengers (as above), cost would be, interest charge included..	2.82 cents.
At 4.38 passengers per car mile (number carried by cable roads), the cost would be, interest charge excluded..........................	2.82 cents.
At 4.38 passengers (as above), cost would be, interest charge included..........................	3.51 cents.

This is not in any way an attempt to decry the cable system, as it is undeniable that it has a place of its own, where it is satisfactory to the public and profitable to the investors; but the claim is that, under all usual circumstances, the electric road can handle just as heavy traffic, as readily and satisfactorily to the public, with much greater economy in operation, and much less investment of capital.

OPERATING EXPENSES OF ELECTRIC ROADS.

Average of twenty-two trolley roads. Length varying from 3 to 51 miles; cars in daily operation, 3 to 140; daily mileage per car, 80 to 150; average daily mileage per car, 110.

	EXPENSES PER CAR MILE. (CENTS.)		
	Highest.	*Lowest.*	*Av'r.*
Maintenance of roadbed and track....	1.86	.10	.54
Maintenance of line....	.95	.01	.12
Maintenance of power plant, including repairs on engines, dynamos, buildings, etc......	.86	.05	.36
Cost of power, including fuel, wages of engineers, firemen, dynamo tenders, oil, waste, water and other supplies	4.95	.48	1.96
Repairs on cars and motors..................	5.24	.59	1.80
Transportation expenses, including wages of conductors, motormen, starters and switchmen, removal of snow and ice, accidents to persons and property, etc....	9 47	2.74	4.98
General expenses, including salaries of officers and clerks, office expenses, advertising, printing, legal expenses, insurance, etc...	2.95	.79	1.26
Total....	*22.99	*7.80	11.02

*Respectively the highest and lowest total for any one road.

Cost of coal varies from $1.00 per ton for slack, to $3.00 for R. O. M. (run of mine), and $3.80 for lump.

Wages of conductors and motormen vary from 10 cents to 20 cents per hour.

Consumption of coal varies from 4.3 pounds of slack per car mile to 12.2 pounds R. O. M. per car mile.

The station output varies from 3.7 E. H. P. (electrical horse power) to 8.4 E. H. P. per car in operation, for roads equipped with 16-foot cars and Edison motors. In the latter case the road had many heavy grades and sharp curves. One road, equipped with 30-foot double-truck cars (weight complete about 10 tons), 6 Edison and 14 Short double 15 h. p. equipments, traffic medium and grades moderate, required an average of 10.7 E. H. P. per car in operation.

The best station performance is 1 E. H. P. for every five pounds of slack or four pounds of nut consumed; and evaporation of 7½ pounds of water for every pound of slack consumed. Return tubular boilers, Murphy furnaces, Armington & Sims high-speed, single cylinder, non-condensing engines, and Edison generators are in use.

DETAILED DISTRIBUTION OF OPERATING EXPENSES.

For roads of ten or fifteen miles and upwards, operating twenty or more cars per day, averaging 105 to 110 miles each, grades moderate, a careful distribution of expenses, based upon the experience of the best roads, will *average* about as follows:

	EXPENSES PER CAR MILE. (CENTS)	
Maintenance of roadbed and track.......		.54
Maintenance of line........................		.12
Maintenance of power plant:		
Repairs on engines and boilers................	.180	
Repairs on dynamos.........................	.101	
Miscellaneous repairs...	.078	.36
Cost of power:		
Fuel......................................	.868	
Wages of engineers and firemen........	.653	
Wages of dynamo tenders, etc...............	.223	
Oil, waste, water and other supplies....	.218	1.96
Maintenance of rolling stock:		
Repairs on motors (ex. gearing)........	.695	
Repairs on gearing and trolleys...............	.594	
Repairs on car bodies and trucks.............	.512	1.80
Transportation expenses:		
Wages of conductors and motormen..........	4.262	
Wages of starters, switchmen, track sweepers, etc.........................	.268	
Cleaning and inspecting cars.................	.238	
Oil, waste and other supplies.................	.083	
Accidents to persons and property............	.061	
Miscellaneous................................	.068	4.98

General expenses:

Salaries of officers and clerks	.743	
Office expenses	.138	
Advertising and printing	.061	
Legal expenses	.068	
Insurance	.161	
Miscellaneous	.091	1.26
Total		11.02

STANDARDS IN ELECTRIC STREET RAILWAY PRACTICE.[1]

BY O. T. CROSBY.

AFTER pointing out the necessity of some uniform standards of nomenclature, dimensions and method of keeping accounts, Mr. Crosby said:

While the adoption of a set of definitions by this Association would in no sense be binding, it would yet tend to make definite that which is now indefinite. As a basis upon which some further and better work in this direction should be done, I give herewith a table showing list of proposed terms, with various terms heretofore used as equivalents, and definitions properly limiting the proposed terms. In some cases when there has been satisfactory uniformity, no equivalents are given, but definitions are suggested. The list can, with benefit, be considerably extended.

NOMENCLATURE OF ELECTRIC RAILWAY TERMS.

Generator.—(Generator, dynamo) Machine in which the electric current is generated.

Motor.—(Motor.) Machine in which the electric current is transformed into mechanical power.

Frame.—(Frame.) Iron body of machine, including pole pieces and standards or side arms, if any, but not including base plates and bearings.

Standards.—(Standard bracket.) Supports of the bearings of generator.

Side Arms. (Side arms, check pieces, armature bracket.) Supports of bearings of railway motors.

Pole Pieces.—(Pole pieces.) That part of frame from whose surface lines of force may pass directly to the armature.

Field Coil.—(Field coil, spool.) Coils of wire wound on frame in such a way that a current passing through these coils makes magnets of the frame and pole pieces.

Brush Holder.—Device for holding the brushes in contact with the commutator, including the insulation used in its support.

Rocker Arm.—(Yoke, rocker arm.) Device for holding brush holders in position on commutator while attaching it directly or indirectly to the frame.

Fuse.—(Fuse, fusible plug.) A metal device for opening circuit when the current becomes abnormally large, the soft metal being melted by a current of fixed quantity.

Switch.—A device for closing or opening a circuit at one or more points.

Rheostat.—(Resistance box, rheostat.) Wire or other material suitably protected and conveniently arranged to be introduced in more or less proportion into a circuit.

Trolley.—(Trolley contact bar.) A device used to transmit the electric current from the overhead wire to the cars, consisting usually of a

Trolley Wheel.—A small metal wheel making rolling contact with the overhead wire.

Trolley Fork.—Mechanically connecting trolley wheel to

Trolley Pole.—Supporting the trolley fork and wheel and resting in a socket, which is part of the

Trolley Base Frame.

Trolley Wire.—Wire from which the trolley wheel directly receives current.

Trolley Frog.—(Frog, overhead switch, trolley switch.) A device used to fasten or hold together the trolley wires at a point where the trolley wire branches, and to guide, ordinarily automatically the trolley wheel along the wire over the track taken by the car.

Trolley Frog.—(Standard Frog.) A frog designed for use at a point where two branch lines make equal convergent angles with the main line.

Right Hand Trolley Frog.—A trolley frog designed for use at a point where a branch trolley wire leaves the main line to the right in the going direction.

Three Way Trolley Frog.—A trolley frog for use at a point where the line branches in three directions.

Draw Bridge Cross Over.—A device permitting the easy passage of a trolley wheel from one to the other of the two adjacent wires in a continuous direction.

1. Abstract of a paper read before the American Street Railway Association, at Pittsburgh, October 22, 1891.

Trolley Crossing.—(Crossing frog, cross over.) A device placed at the crossing of two trolley wires by which the trolley wheel running on one wire may cross the other; the device also holding the two trolley wires together.

Insulated Trolley Crossing.—A device placed at the crossing of two trolley wires, by which the two wires are insulated from each other, and by which the trolley wheel running on one line may cross the other.

Hanger.—(Line insulator, line suspension, trolley insulator.) A device for supporting and insulating the trolley wire.

Straight Line Hanger.—The hanger used on a straight line and supported from a span wire, the strain on same being essentially vertical.

Single curve hanger.—The hanger supported by a lateral strain in one direction and, ordinarily, on single track curves, except at ends, and the inside curve of double track.

Double Curve Hanger.—The hanger supported by lateral strain in opposite directions, used ordinarily at ends of both single and double curves and at intermediate points, and on double track curves.

Feeder Clamp.—Clamp with a device by which a feed wire may be coneected to the trolley wire.

Feeder.—A wire usually insulated, used for transmitting current from the power station to the mains or the trolley wire direct

Mains.—Wires usually insulated, serving for the distributing of current from the feeders to the trolley wire through tap wires.

Tap Wires.—Wires to convey current from feeders or mains at the pole to a near point of the trolley wire.

Trolley Section.—A length of one trolley wire with or without branches but continuous electrically.

Line Section.—A part of the overhead conducting system so insulated from other parts as to permit the supply of power to be separately controlled.

Section Box.—A box containing section switches and fuses used for control of a trolley section or line section.

Mr. Crosby then discussed standard methods of keeping accounts, exhibiting a number of blanks for the use of electric railway managers.

He said: In regard to standard methods of keeping accounts, I am permitted to present information prepared by Mr. W. E. Baker, of the Thomson-Houston Electric Co., long in charge of their work of maintaining of motors and lines for the West End Street Railway Co. Whether or not this Association should take any action, such as recommending one or another method of keeping accounts, I feel sure that Mr. Baker's suggestions will be of value to those who will consult them.

The first and most important matter in the expense accounts is the classification or division of expenses, and the second practical matter is how to separate into these divisions the expenses, without too much detail or clerical labor. For this purpose a manual should be carefully prepared.

In this manual there should appear four general divisions of expenses, namely: General expense, transportation expense, maintenance of way and buildings, and maintenance of equipment. Under these are subdivisions, and under each are clearly expressed the proper labor or material to be charged to them.

There has been considerable discussion of late in regard to a standard unit for the comparison of experses on electric roads. It may be doubtful if such standard unit can be satisfactorily agreed upon or will satisfactorily express the result; but, at any rate, it must be composed of some function of the results of operation.

The next matter is how to arrive at and keep these expenses sufficiently accurate and without too much clerical labor; and this brings us primarily to the Stock or Supply Account.

A careful record should be kept of all material received and all material used, on blanks bound in book form.

An invoice book with copies of all bills should be kept, and a monthly summary of both books will be made giving from the invoice book all the charges to stock, and from the material used all the credit to stock and all the charges of material to expense properly classified. If, in addition, a stock ledger is kept it will be found that all errors and mistakes in foremen's and in clerks' pricing, etc., will correct themselves, and it will easy at any time to check up the ledger with the material actually on hand in the stock room.

To summarize: If the superintendent, as is frequently the case, has an office distinct from the office of the company, he would be required to have the following books: Stock ledger, time books, pay rolls, material used and material received book; and copy books as follows will be a convenient arrangement: A letter book, a copy book for pay rolls, a requisition book, unless he buys his own supplies wholly, when this becomes an order book, a daily report of earnings' book or deposit book, a motor book for copying reports, and a statement and bill copying book for bills made against other parties; and the monthly reports to be made will be about as follows: Mileage report, material used report, balance stock ledger, receipts report, invoice summary. The daily reports would be of daily earnings and of condition of motor cars.

THE

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. XII. NEW YORK, OCTOBER 28, 1891. No. 182.

Electric railroading, city, town and suburban, is here for our upbuilding and national prosperity, as surely as steam railroading was fifty years ago.—G. W. Mansfield.

THE AMERICAN ELECTRIC RAILWAY ASSOCIATION.

NO one who attended the great convention of street railway men at Pittsburgh could fail to see that it was to all intents and purposes an electrical meeting; and if the American Street Railway Association were forthwith renamed the American Electric Railway Association the new designation would hardly be inappropriate. Out of the 600 delegates and visitors a very small proportion had anything to do with horse or cable interests, and with the exception of one excellent but belated paper on cables, the whole work of the two active days lay in the discussion of electricity as a motive power for street railroads. When we remember that barely four years ago there were only a baker's dozen of electric roads, and that only two years ago a horse railway delegate wanted to put down all these new-fangled electrical ideas, one cannot but feel that success has been reached in a remarkably short time, and that after all the reward of persistent advocacy is seen in an industry that already embraces over 400 roads, or nearly half of all there are in the country to-day.

Just what the advance in this application of electricity is may be gathered from the figures presented by President Watson and quoted elsewhere in our columns. To these figures we are glad to be able to add those of the Census of 1890, now published for the first time, and furnished us kindly by Superintendent of Census, the Hon. Robert P. Porter, upon our application for them. These figures are the grand totals for the year ending June 30, 1890, since which time, it may be added, the electric roads have more than doubled; in fact, they have nearly trebled in some respects.

ITEMS.	All Motive Powers.	DISTRIBUTION.			
		Animal.	Electric.	Cable.	Steam.
Length of line	5,783.47	4,061.94	914.25	283.22	524.06
Length of all tracks	8,123.02	5,661.44	1,261.97	488.31	711.30
Number of cars	32,505	22,408	2,895	5,08[illegible]	2,113
Number of employees	70,764	44,314	6,619	11,673	8,158
Number of passengers	2,023,010,202	1,227,756,815	134,905,994	373,492,708	286,854,685
Total cost	$389,357,288.87	$195,121,682.50	$35,830,949.63	$76,346,618.28	$82,058,038.51

These figures are already changing. Thus, for example, since they were taken, the number of horses employed has, according to Mr. Watson, fallen off about 30,000; at which rate there will probably be none left by 1891. It will be observed again that the cable roads, 488 miles in length, cost $76,346,618, while 1,261 miles of electric, or nearly three times as much, cost only $35,830,-949. Another noticeable feature is that the horse cars, then numbering 22,408, required 44,314 employees. The electric cars then numbered 2,895, or only one-seventh as many, but with only 6,619 employees they carried nearly one-fifth as many passengers. It is matter of congratulation that, realizing the importance of street railway census statistics, the association passed a resolution asking that those of the electric roads be given with all the fullness possible, so that we may all have the information that is desirable and needful in marking the advance and amazing growth of this industry.

ELECTRICITY AND PLANT LIFE.

Mr. Steinmetz makes some very interesting suggestions in our columns this week relative to the effect of electricity on plant life. So far the work of investigation has been pursued along two lines, namely, the application of the current to the soil, and the use of the electric light; but we are not aware that there has been tried a combination of the two methods. Mr. Steinmetz, meantime, points out that some of the very evils that are attributed to an excess of the electric light may have been turned into benefits. If plant life and maturity may be stimulated by the light to such an extent as the Cornell experiments indicate, why should not crops of great value be cultivated far north of the line that now limits them? And why should it not be possible, as Mr. Steinmetz suggests, to euchre a frost that would otherwise destroy a whole grape crop and spoil the vintage? Even if the plants suffered to some extent from the stimulus, a partial crop would be better than none. In the case of flowers, the use of the light in intensifying color, etc., would not be less objectionable than is the use of coffee in the midnight hours by intellectual workers. It would be interesting, further, to try the effect of the light in the case of diseased plants or those whose leaves are infested by parasites. Altogether, it seems to us, and especially with the adoption of such suggestions as Mr. Steinmetz throws out, there is reason to believe that the electric light can be profitably used in the stimulation of plants without impairment of quantity or quality. It will be rather singular to see electricity taking the place of manure.

HOW TO OPERATE ELECTRIC ROADS.

There are many practical questions connected with electric railway work that might well be brought before the American Street Railway Association for discussion; but so far the papers listened to by that body have not been as helpful to managers and superintendents as might be expected. We are glad to note, therefore, that at Pittsburgh three excellent practical papers were read; and while these papers, by Messrs. Everett, Crosby and Mansfield, left a great many points untouched, they gave a wealth of information on some very vital subjects.

Mr. Everett's analysis of the features of a perfect street railway motor deserves commendation, but we do not quite follow him in his criticism of the price of equipment. If, as he says, the manufacturing companies could sell 40,000 cars instead of 4,000, were prices only lower, we may take it for granted either that the present manufacturers will cut prices or else that a dozen newcomers will compete with them for the business. Both contingencies may probably occur at once, but our opinion is that Mr. Everett exaggerates. When we see a new industry growing with giant leaps and bounds, it is pretty safe to assume that prices for apparatus cannot be very much out of the way. We do, however, expect to see the local street railway companies do all of their own repair and reconstruction work, and possibly some of them may build their own "spare" parts.

Mr. Mansfield's paper was worthy of his ability and of the experience that in spite of his youth he has gained as a pioneer engineer and inventor in this field. His remarks on trolley and guard wires were pithy to a degree, while his advice to bury all the feeders was as good as any given throughout the meeting. We do not quite share his pessimistic views touching conduit and storage systems. Our faith has been somewhat shaken by the failures of the past, and yet it seems to us that some of the conduit systems now known might be made to meet the situation fairly well. So, too, with storage battery cars. We do not entertain the belief that the arguments for them are, to use Mr. Mansfield's sharp words, "sophistries for the blind and unthinking." On the contrary, the work now being done deserves all possible encouragement, and we shall watch it with hopeful feelings and in a very kindly spirit. The reception given Mr. Neftel's little paper showed that his hearers were still willing to be convinced of the practicability of the storage battery system.

As usual, Mr. Crosby handled his subject of "standards" in a most masterly fashion, and it is devoutly to be hoped that the tendency towards standardization will make itself felt thus early, when the opposite tendency is naturally very strong. Steam railroading furnishes many a lesson and example in this particular respect. As with apparatus so with accounts. We have recently employed our pages in suggesting the best methods of finance and managment for central stations; and it is evident that the need of system is not less in electric railway work.

The above papers, with the very useful and exhaustive figures contributed by Mr. J. S. Badger, on electric railway construction, maintenance and profit, constitute a valuable résumé of the state of the art and of themselves made the Pittsburgh meeting as helpful as any of its predecessors.

Gearless Motors.

Many electrical engineers who visited Pittsburgh, last week, saw gearless electric railway motors for the first time. Opinions were, of course, varied, but, on the whole, the gearless may be said to have made a very favorable impression, and, under test, to have verified many of the claims made for it. Coming so quickly as it does upon the heels of the excellent single-reduction motors now in use, the public has scarcely been ready for it; but while to-day belongs to the single-reduction, it certainly looks as though to-morrow belongs to the gearless, unless something else equally meritorious arrives on the scene.

Oil as Insulation.

An interesting contribution to the history of oil as insulation is made in our pages this week by Mr. F. L. Pope, whose article deserves careful reading, especially in view of the recent work at Lauffen. With regard to that work, it would be valuable to know why the voltage was not carried up to 30,000 as originally proposed, but fell short at 18,000 or 20,000 volts. Our own impression is that the restriction to this lower voltage was due to heating up and the prevention of rapid radiation by the oil. This is open to remedy, and may not have been a serious trouble, but it is certainly one of the possibilities about which we would be glad to learn a little more.

A PERFECT ELECTRIC MOTOR.[1]

BY H. A. EVERETT.

In his report upon "A Perfect Electric Motor," Mr. Everett gave a brief history of the electric motor, its imperfections, and the steps taken to overcome them, and, after bringing the subject down to date and discussing the usages of various railways, summed up his idea of a perfect motor as follows:

Taking the trolley wheel, pole, and stand, I think it desirable to have a wheel that is capable of following the wire at any angle, with a trolley pole brittle enough to break should it become entangled in the wires, without pulling them down, and a trolley spring rigid enough to give good, steady pressure on trolley wire, and so constructed that when the car is in the car house or going under a low bridge, the pole could come very close to the roof of the car, also flexible enough to give good pressure when the trolley has to be 21 or 22 feet high at the railway crossings.

The car should have a lamp circuit, with plenty of lamps distributed properly.

The perfect motor ought to have, as hereinbefore suggested, a reliable fuse plug, that will invariably blow before injury is done to the machine.

Have on each car the best lighting arrester that can be secured in the market.

In coming to the motor proper, it is desirable to use a controlling switch that is easily operated and readily reversed, in case of accidents. The simpler the controlling device the better, and it should be constructed with a view to guard against any possible disarrangement of the parts, so that it will be reliable in all cases, both electrically and mechanically.

The rheostat should also be carefully looked after, and properly protected to keep it from injury, by reason of water, snow or dirt getting upon it. It should only be available in starting the car to avoid the lunge of a start, and should be so arranged as to be cut out as soon as the car is started, and give the entire efficiency of the motor proper.

The motor should be well protected in all its parts from any outside interference, so that in running along the street it will be impossible to pick up nails, wire, or anything that would short-circuit it, at the same time observing that a motor must be properly ventilated to keep it from heating while in use. The cover should be made so as to be easily removed.

I deem it very advisable to have an armature of a large diameter, making a small number of revolutions per minute, with the bearings made of extreme width with proper grease-cups, and in such a condition that they can be readily re-babbitted when slightly worn.

The diameter of the commutator should also be large, and to have the brushes easy of access is very desirable. The winding of the armature ought to be of the simplest kind, and the size of the wire and insulation of same should be carefully looked after. I think the insulation of wires in armatures is at present one of the weakest points in the motor.

The armature gears should have a wide face, and run in oil. The armature shaft ought to be of ample diameter, and there is nothing gained by having the keyway too small for the securing of the commutator to the shaft. The commutator should be carefully insulated, so that there will be no grounds between it and the case. The box in which this gear runs ought to be constructed of copper, or some light material that is somewhat flexible, so that if struck from the outside it will bend rather than break. The fields should also be wound with a wire of better insulation, and of ample size to take the current. Of course, in this particular, I do not intend that the wire of either the field or armature should be great enough to take more horse power than ought to be used by the machine. To my mind it is very desirable to have the armature in such a condition that it can be readily taken out from the machine and put in again.

One of the serious disadvantages to operators of electric roads is the expensive labor necessary in winding the armatures and fields, also in regard to high-priced mechanics who ought to be employed to attend to the machines. There is nothing gained in employing a cheap class of labor to handle an electric equipment either as electricians, armature or field men, or mechanics. This proposition is a self-evident truth, as can readily be observed in many roads now in in operation.

At present, I think the single-reduction motor is the nearest perfection of any on the market.

I think it very desirable that the electric companies should devote some time to the perfection of an electric brake to stop the car with the same power that runs it. This could be readily done, and would be a satisfactory improvement.

Electric heaters are now used in quite a number of places, and I think will prove quite satisfactory.

I have noticed electric signal bells on some of the cars, and they seem to work very well.

For a dasher gong on a motor car I am in favor of a foot tread, as in testing an electric gong we found that our men used it altogether too freely.

I am in favor of an oil head-light, one that can be removed easily, so that in the event of a trolley being broken or anything happening to the electric part of the car, or a light is desired underneath the car, the oil head-light can be used to better advantage than the electric. There ought also to be one oil light in every car for the same purpose. There is no reason why an electric fare register cannot be made to work successfully.

The durability of a motor is a question which requires very careful attention. The single reduction motor, when properly looked after, ought to last for many years. We have had one in operation for over 10 months, and it appears to be in as good condition as when it first went on the road. The car should be of moderate size, constructed with all modern convenience, but without fancy decorations or any unnecessary display.

The cars should be run on frequent headway, and at all hours of the day and night, at as high a rate of speed as the civic authorities will permit. The noise of the motors has been very largely done away with, and by careful attention the old countershaft machines can be used until worn out by simply covering the gearing with an oil box, and by not attempting to run them too many miles without inspection.

1. Abstract of a report presented to the American Street Railway Association, at Pittsburgh, Oct., 1891.

TENTH ANNUAL MEETING OF THE AMERICAN STREET RAILWAY ASSOCIATION, PITTSBURGH, OCTOBER 21-22, 1891.

The above meeting was begun at the headquarters of the association, the Monongahela House, at 10 a. m., on October 21. The convention was the largest ever held by the association, there being not fewer than 600 delegates and supply men in attendance during the week.

President Watson opened the proceedings with an excellent address, of which the following is an abstract:

THE PRESIDENT'S ADDRESS.

The president, after thanking the people of Pittsburgh for the warm reception tendered the association, said:

"The most important matters to be discussed in convention will be the problems which arise in the application of electricity to street railway traffic. It is a source of no little satisfaction to us to know that, in the development of the electric railway, America leads the world. Three years ago there were only 13 electrical roads in the United States; now there are over 400, and the advices from every part of the country indicate that before the close of the present year the number will be increased to 500. The capital now invested in American electric railways exceeds $75,000,000. 'Horse sense' counts for but little in this age of rapid transit. We old dogs have been obliged to learn new tricks, and without the usual privilege of serving an apprenticeship. Our stables are being converted into power-houses; the electrician has taken the place of the veterinary surgeon; our drivers are being educated as motor-men, and most of us have horse cars for sale.

"The following statistics have been compiled from returns made by street railway companies in the United States and Canada to the middle of September, and are believed to be as reliable as it is possible to make them:

Total number of miles	11,030
Number of miles operated by animal power	5,443
" " " " electricity	3,009
" " " " steam motors	1,918
" " " " cable	660
Total number cars employed in street railway traffic	36,517
Number of cars operated by animal power	25,424
" " " " electricity	6,732
" " " " cable	3,317
" " " " steam motors	1,044
The number of horses employed	88,114
" " " mules "	12,002
" " " steam motors	200
Number of companies operating street railway lines	1,003
Number of companies operating by animal power	537
" " " " electricity	412
" " " " cable	54
" " engaged in building new lines, about	75

"It is interesting to note that since November, 1890, the number of horses employed on street railway lines has fallen from 116,795 to 88,114; that is, 28,681 in one year. At this rate it will not take long to emancipate the horse from street railway business.

"According to the official figures taken from one of the street railway journals for the month of October, 1891, Philadelphia leads with 510 miles of single track; and after the Quaker City comes Chicago with 452 miles, New York with 289 miles, Brooklyn 285, Boston with 283, St. Louis 275, Baltimore 207, San Francisco 205, Cleveland 192, Cincinnati 180, Pittsburgh 168, Kansas City 141, New Orleans 139, Louisville 132, Buffalo 110, Minneapolis 101, Los Angeles 99, Detroit 94, Birmingham (Ala.) 92, St. Paul 90, Washington, 85.

"The official figures of the census just completed show that in December, 1889, 476 cities and towns possessed rapid transit facilities; and it is now difficult to find any town of 5,000 inhabitants without one or more street railways.

"While a large majority of us are interested in electric street railways, electricity will not be permitted to monopolize this convention. One of the features prepared for us will be the report of a special committee on 'A Year's Progress in Cable Motive Power.' This is well. We should not become so deeply interested in any one form of rapid transit as to lose sight of the good points of all others."

"Since the introduction of cable and electric transit," Mr. Watson continued, "some of the lines have been made U. S. mail routes. The plan is to place boxes for the collection of mail matter on all the cars. The mail is then sorted at some central point, and sent to the sub-stations without delay. In a city where all the cars come to a common centre, the plan seems feasible, and it is suggested that other companies consult the local postal authorities on the subject at an early day."

Mr. Watson closed by referring to the pleasure and benefit expected from the World's Fair in 1893, to the growth and strength of the association, and to the able work of the street railway press.

The report of the executive committee showed the association to consist of 187 companies, 22 having joined during the past year, and four having withdrawn. "Street Railway Law" has been enlarged by the addition of Vols. VII and VIII, consisting of the monthly reports of judicial decisions relating to street railway work. Attention was called to the fact that a hearty invitation had been tendered by the Rochester Railway Company to the association to hold its next convention in that city. The committee took occasion to express gratitude for the hospitality with which the visiting delegates had been received at Pittsburgh, and, in closing, called attention to the fact that, although the past year has been one of unusual mortality, no loss has occurred to the association by the death of any one of its representatives.

The convention then listened to a report by Mr. H. A. Everett, of Cleveland, on "A Perfect Electric Motor."[1]

A discussion arose on this paper as to the cost of electric operation.

MR. HENRY, of Pittsburgh, said: I have in my hand a copy of my last report. Our total cost, including conductors and motormen, all repairs, maintenance of way, general expenses and all other charges, amounted to 20.26 cents per mile. Separating this into strictly operating expenses, and fixed charges, we have operating expense of 12.74 cents per mile, and in comparing the same with the cost of operating the horse line, which was 10 cents per car mile, we must remember that we then paid but one man on a car. We paid four or 3 cents per mile against 6.60 cents now. This increased cost per mile for conductors and motormen is a necessary adjunct of rapid transit, and is not peculiar to the system. Allowing this, we have a difference of 1.04 cents per car mile in favor of electricity as against animal power.

MR. BICKFORD, of Salem—We have equipped our lines and run 12 cars. Formerly it took 18 cars to do the work 12 now do. One line where we ran twelve cars by horses, we run eight electric cars and carry more passengers.

MR. STEPHENSON, of Washington—That is the general information that I get. We have about 20 cars on our road, and I am satisfied that when we put on electricity 12 or 14 cars will carry the same number of people as the 20 now do. I am also satisfied that we shall have an increase in our travel of 25 or 50 per cent.

MR. PEARSON, of Boston—I think I can give some information on this subject. Our road has about 350 cars equipped with electric motors. The expense of operation with horses is about 25 cents per car mile, including everything connected with the operation, fixed charges and track repairs. In Boston the cost of operation is quite high as compared with some other cities. You will find in many cities the cost of operation of horse cars is below 25 cents, but we pay a good price for labor, on account of the running of our lines in the congested parts of the city, where we cannot get as much work out of a man as you can in other cities. This makes a greater cost of operation. The cost of operation with electric motors up to the present has been about 20 cents per car mile. The increased cost of operation in our city is also true to a great extent with electricity. We pay 25 cents a day more for motormen and electric car conductors than we do for horse conductors and drivers. That has been our experience up to this time. We save about 25 per cent. Our men are expected to work 10 hours a day, but we really get anywhere from 7½ to 9½ hours a day. The amount of power consumed is considerably more on account of the slow speed with which the motor cars have to operate in the downtown sections of the city. There the streets are crowded with teams and cars, and I suppose that the cars run at an average of perhaps one or two miles an hour for a distance of from one-half to one mile, which of course decreases the profits very materially. We expect to get the cost of operation down to 16 or 17 cents per car mile. Another item of expense to us is the high cost of power, we having been obliged to hire power from an electric light company and pay them a good price for it, of course much more than it would cost a street railway company if they had their own power house. As I said before, the saving of electric cars, as compared with the horse system, is about 25 per cent., being about 20 cents per car mile for the electric cars and 25 cents per car mile for horse cars.

MR. RICHARDSON, of Brooklyn—I would like to ask Mr. Pearson, before he takes his seat, what size cars his company has operated in its electrical propulsion and what size he thinks, from his experience, would be the best and most economically operated, all things considered.

MR. PEARSON—We began with a sixteen-foot motor car very similar to the old horse cars. We have changed from that to a long car, which is 26 or 28 feet long in the body and 35 feet over all; that is the car we have adopted as our standard. For our purpose we find a decided improvement in earnings and saving in operating expenses per passenger with the long car. I imagine that the conditions in Boston determine that for us, and in other cities it may be that the short car would be more profitable for operation. We find the long car earns a great deal more per car mile, and we need only the same number of men to operate it as with the short one. From our tests we find that the amount of power consumed on a level track is very little more for the long car than with the short one; in fact, the weight which we have in the car seems to have little to do with the current consumed, as long as the car is on a level track. From tests, we found that with a long car empty, weighing, perhaps, 18,000 pounds, using a certain average amount of current, the same car loaded with 15,000 pounds of weight used very little additional power until we come to a grade. We have experimented in this matter, and could hardly tell from the reading which was the empty and which was the loaded car. That being the case, it does not cost much more to operate long cars than short cars. Again, they carry nearly double the people, and do it with the same expense for conductors and drivers. Just how much more heavy cars will increase the track repairs of course we cannot tell at present.

MR. SAGE—Did you increase the headway?

MR. PEARSON—No, we are on the same headway.

MR. SAGE—Where do you get your additional passengers?

MR. PEARSON—They prefer to take our cars rather than the steam railroad. A great many people who formerly travelled on the steam road for short trips prefer to take our electric cars. The ride is pleasant, and in the suburbs we go very quickly.

MR. BALLARD, of San Antonio—I happen to know, from having seen the figures, a good many roads, and the profits they made were absorbed in paying bills for the new equipment. The shareholders, instead of making more advances of money, allow the profits to be used for that purpose. As to the advantages of these electric roads over a horse road, I do not think sufficient allowance is made for the natural increase of travel, and that people prefer to ride on an electric car. In the city of San Antonio the entire line has been equipped within the last year. The total gross revenue of the old horse line running regularly was about $6,500 a month. We are now running at an average gross income of $12,000 a month, with only an increase of the population of about 2,000. Our increased receipts are nearly 100 per cent.

MR SAGE—Have you increased your mileage?

MR. BALLARD—Very little. The increase in traffic is enormous.

MR. WM. RICHARDSON—Will the gentleman kindly state how much the cost of operation in the aggregate has been increased?

MR. BALLARD The increase is only twelve per cent. Our total outlay for operating expenses in earning a revenue of twelve thousand dollars a month, against sixty five hundred dollars a month, is only an increase of twelve per cent. I would also like the gentlemen to bear in mind that we have to pay five dollars and one-half for every ton of coal that we burn.

Adjourned.

EVENING SESSION, OCT. 21.

At the evening session a valuable paper was presented by Mr. G. W. Mansfield on "The Dependent—Overhead or Underground—System of Electric Motive Power."[1]

After the reading of this paper, some discussion arose as to the size and value of guard wires, Mr. Mansfield having suggested No. 14 as a good size for guard wire, Mr. Bickford said he preferred a No. 10 of steel.

MR. LITTELL, of Buffalo—I wish to ask Mr. Mansfield if he does not think it advisable to cut up his guard wire into sections of, say, one thousand or fifteen hundred feet, and put in circuit breakers, so that if any wire does fall, the current will not be sent a great distance.

MR. MANSFIELD—I would advise it, and it is done on many

1. See page 482.

1. See page 475.

roads; the West End road, of Boston, I believe, do it every five hundred feet.

MR. LITTELL—It is done in Buffalo.

MR. WATSON, of Cleveland—Mr. McKinstry, who is manager of the telephone lines in Cleveland, informed me that his telephone wires in the centre of the city did not last much over a year, sometimes a year and a half. In our span wires we used a galvanized steel wire, and at the end of a year and a half they were rusted to such an extent that we dare not tighten them up. We have a chemical works and an oil works in Cleveland, and we do not know whether or not it is due to the gases that come from these factories. I believe our road was the first one to use the soft drawn copper wire for span wires. The reason of using this in preference to hard drawn wire, or silicon bronze, was that silicon bronze was very brittle. We used a soft drawn number four, the same as for the ground work. That has been up now over a year, and there has been no perceptible elongation or stretching or sagging.

MR. RICHARDSON—I have had submitted to me a copper triangular tube, if I may so call it, intended to cover over the trolley wire and to guard it thoroughly from any interference with wires that might otherwise come in contact with it; I wish to ask the gentlemen's judgment of that device.

MR. MANSFIELD—I have looked into a great many methods of protecting the trolley wire outside of the stringing of additional wires, but I have not seen any which in my judgment would lead me to adopt it upon any road where my advice was asked. The trouble is that most of these devices will warp and twist, and unless they are made very large the trolley wire may swing to one side or the other. They entail heavy span wires and an additional strain upon the side poles for their support. In the winter time the top of these devices will be covered with a large accumulation of ice and snow, which throws a greater weight upon the span wires and strain upon the side of the poles, for their support. Then again they are difficult to put in place and maintain in place. That is the result of my observations, and I do not think there is anything as good as what is generally accepted and used to-day.

Adjourned.

THURSDAY MORNING SESSION.

At the opening of the morning session a paper was read by Mr. G. Hilton Scribner on "The Public and State Treatment of Corporations." It was an arraignment of both political parties as to their behavior respecting corporations, and a most eloquent plea for the work that such bodies can do in promotion of public welfare.

Next came a paper by Mr. Knight Neftel on "The Independent—Primary or Storage Battery—System of Electric Motive Power."[1]

MR. BAUMHOFF, of St. Louis—The Company which I represent have experimented with the storage battery, and I must say we have had no success. We had two cars, each equipped with one hundred and twenty cells on an average grade of two and one-half per cent., the steepest grade not over three and one-half per cent. We were unable to get a greater mileage than from eighteen to twenty-two miles out of each charge. The charging of the cars required from eight to twelve hours. We found also that aside from the leakage and the spilling of the liquid, the cells buckled and corroded, caused possibly by acids. We expended a large sum of money in these experiments, but finally gave them up as a hopeless undertaking. The storage battery is certainly not a commercial success.

MR. NEFTEL—I believe the experiments the gentleman refers to must have been made at least four years ago. In the past four years a great change has come over everything connected with the storage battery; and the storage battery of this day, as manufactured by the leading companies, is an entirely new thing. Great progress is going on in this direction, and we are not justified in throwing the thing aside as a failure. I remember five years ago receiving a letter from the Thomson-Houston Co., which I have preserved as a curiosity, asking me whether I thought electric traction would ever be successful, and whether it would pay an electric light company to manufacture motors for electric traction.

MR. BARR, of Newark, N. J.—On this question of storage battery I only wish to refer to the road in Philadelphia of which Mr. Sullivan is president. The Lehigh Avenue Passenger Railway was built to operate storage battery cars. In May, 1890, the road started with six storage-battery cars. In October, 1890, application was made to the city council of Philadelphia for the use of the overhead system, claiming that unless they could use it they would have to abandon the road. The council refused permission to the company to use the overhead wire, and on the 1st of Januars, 1891, the storage-battery cars were abandoned and the road has since been operated by horse power.

MR. VHAY, of Detroit—I represent a road which has, perhaps, experimented with the storage battery system more than any other road in this country. The Woodward storage battery put their car on our road for about a year and a half. The system worked very well. The cars ran at the rate of about twelve or fourteen miles an hour. The cost for coal was considerable, being ten dollars per day for one car. The trouble seems to be that it takes from seven to ten hours to charge these plates, and it is not possible to make over thirty-five miles a day; they make about four trips. Sometimes they can get into the house and sometimes they cannot. There were no grades, but some sharp curves. We thought that ten dollars a day for coal, two dollars and a half for the services of an engineer, and getting only thirty miles out of the battery was not much of a commercial success. We now have a road with cylinder underground filled with compressed air, and by cylinders connected with the car enough air pressure may be taken from the underground cylinder when the car stops for a passenger to propel it half a mile. The people say that it runs like a scared cat.

MR. NEFTEL—I think it is a mistake to expect batteries to make a long run. If we have a perfected storage battery system it will not be a system in which cars will run for one hundred or two hundred miles; but it will be a system in which each car will make one trip, and then newly charged batteries will be put in the car. The batteries can be changed easily, and there is no earthly object in dragging them along for thirty, forty or fifty miles; it is taking along an unnecessary weight in lead.

MR. E. A. SCOTT, of Philadelphia—I am the representative of the company that has put in two successful plants in Dubuque, Ia., and Washington, D. C. We are now operating them as a commercial success. The gentlemen connected with these roads, if they are here, can probably tell you better than I what the result has been. As Mr. Neftel stated, there is no more necessity to run a battery one hundred miles than there is of making a span of horses pull a car that distance. You can work a pair of horses until they drop in their tracks, and you can do the same with the battery until it becomes exhausted, but there is no necessity for it in either case. If you want to know whether any road can succeed, take the successful roads that are running at the present time. Go to Washington and examine the road there, and you will be delighted with the way the cars run. As to the length of time it takes to charge a storage battery, it has been correctly stated that it takes as long to charge it as to discharge it. We calculate to run about twenty or twenty-five miles before we make a change of the batteries; and if they are run in that way on a road where grades do not exist beyond five or six per cent. there is no trouble.

The question of how expensive the system is going to be is controlled by the question of how often you are going to renew the positive plates.

MR. CLEMINSHAW—How many cars on the line in Washington?

MR. SCOTT—Six; and nine in Dubuque.

MR. CLEMINSHAW—How long have they been running?

MR. SCOTT—Since early part of May in Dubuque, and about three months in Washington. On certain portions of the road in Washington they are making fifteen miles an hour. If the experience of everybody connected with the cars is to be believed, they run on their time as regularly as any other system, whether electric, cable, or horse. I noticed in the paper that was read this morning that the question of comparative economy in running is stated to be about that of horses. We believe from what we know that it is considerably less than horses, although we have no figures to show. We believe that in about a year it can be run in competition, so far as economy is concerned, with any overhead system.

MR. MONTAGUE, of Yonkers.—I have seen within three months a storage battery car, not the Edco, that will take eighty-five passengers on a sixteen-foot car and carry it up a grade of ten per cent, and do it easily and steadily. It takes an hour and thirty minutes to charge the batteries. They do not allow the batteries as a rule to run more than twenty or twenty-two miles; but on Decoration Day of this year three cars ran, respectively, forty-two, forty-six and forty-eight miles. When they came to the power house, the engineer had gone home, and they remained outside all night. In the morning there was sufficient power left in the batteries to take the cars into the house. It takes about thirty seconds to change the batteries. These cars run on the level ground at a speed faster than most city governments will permit, and in mounting grades they go quite fast. On one occasion a car was mounting a grade with thirty people in it. I got off and walked along side of the car, and it was not until it had reached the top that I could keep pace with it. The grade was about five per cent.

MR. RICHARDSON.—How many cars are run?

MR. MONTAGUE.—Six cars.

MR. RICHARDSON.—I want to state what seems to me to be a fair inference from what these gentlemen have told us and from my own investigations on the subject, and that is, the storage battery system seems only appropriate for roads running very few cars and on a headway of perhaps ten or fifteen minutes.

MR. HOLMES, of New York, entered into a calculation to show that the power required for the storage car as compared with the trolley car was in the proportion of 215 to 118, or nearly two to one. Mr. SCOTT figured that it took 1¼ h. p. per car mile for a storage car, and he doubted if the trolley cars could do much better.

1. See page 485.

A resolution was adopted calling for a report giving data on the best kind of engine for traction power plants.

MR. LITTELL, of Buffalo, then offered the following resolution:

Whereas, The American Street Railway Association having learned that the collection of the statistics of electrical railroads for the Eleventh United States Census has been transferred to the Division of Manufactures, and placed in charge of Mr. Allen R. Foote, special agent for the collection of statistics of the electrical industries; and

Whereas, The development of electric railroad construction and operation is of such recent date that nearly three times as many such roads are now in operation as in the census year; and

Whereas, Those interested in street railroads, in common with those in other branches of the electrical industries, regard a complete and accurate report by the United States Government of all electrical statistics, and especially those pertaining to electric railroads, as of vital and far-reaching public importance:

Be it resolved:

1. That this association approves of the action of the Superintendent of Census in placing the collection of the statistics of electric railroads in the Division of Manufactures, and in charge of Special Agent Allen R. Foote.

2. That it requests Superintendent Porter of the Census Bureau for the census year to collect and report the complete statistics for electrical railroads down to the date of publication, and thus give to them their highest degree of value.

3. That a committee on census composed of five members be appointed by this association to represent it in an effort to secure ample provision and authority for a complete census of the electrical industries, and this association pledges itself to support all reasonable measures to that end. Carried.

THURSDAY AFTERNOON SESSION.

A report was presented by Mr. Oscar T. Crosby on "Standards in Electric Street Railway Practice."[1]

At the conclusion of his report, Mr. Crosby made the following motion, namely, "That a committee on standardizing of ratings, nomenclature, dimensions and accounts for electric street railways be appointed by the association." Carried.

The committee on nominations reported in favor of the following officers for the year 1891-2:

For President, John G. Holmes, Pittsburgh, Pa.
First Vice-President, Thomas H. McLean, New York, N. Y.
Second Vice-President, James B. Speed, Louisville, Ky.
Third Vice-President, Albion E. Lang, Toledo, O.
Secretary and Treasurer, Wm. J. Richardson, Brooklyn, N. Y.

Executive Committee:

Henry M. Watson, Buffalo, N. Y.
Lewis Perrine, Jr., Trenton, N. J.
W. Worth Bean, St. Joseph, Mich.
Murray A. Verner, Pittsburgh, Pa.
Thomas C. Pennington, Chicago, Ill.

The committee also recommended Cleveland, O., as the place for the next meeting.

All these recommendations were duly adopted. The convention then adjourned.

THE INDEPENDENT—STORAGE OR PRIMARY BATTERY—SYSTEM OF ELECTRIC MOTIVE POWER.[1]

BY KNIGHT NEFTEL.

OWING to a variety of causes, the system which was assigned to me at the last convention to report on has made less material progress in a commercial way than its competitors.

PRIMARY BATTERIES.

So far, primary batteries have been applied only to the operation of the smallest stationary motors. Their application in the near future to traction may, I think, be entirely disregarded. Were it not a purely technical matter, it might be easily demonstrated with our knowledge of electro-chemistry that such an arrangement as an electric primary battery driving a car is an impossibility.

In view of the claims of certain inventors, I regret to be obliged to make so absolute a statement; but the results so far have produced nothing of value.

SECONDARY BATTERIES.

The application of secondary or storage batteries to electrical traction has been accomplished in a number of cities, with a varying amount of success. Roads equipped by batteries have now been sufficiently long in operation to allow us to draw some conclusions as to the practical results obtained and what is possible in the near future. The advantages which have been demonstrated on Madison avenue, in New York; Dubuque, Iowa; Washington, D. C., and elsewhere may be summarized as follows:

First. The independent feature of the system. The cars independent of each other, and free from drawbacks of broken trolley wires; temporary stoppages at the power station; the grounding of one motor affecting other motors, and sudden and severe strains upon the machinery at the power station, such as frequently occur in direct systems; the absence of all street structures and repairs to the same, and the loss by grounds and leakages, are also very considerable advantages both as to economy and satisfactory operation.

Second. The comparatively small space required for the power station. Each car being provided with two or more sets of batteries, the same can be charged at a uniform rate without undue strain on the machinery of the power station, and as it can be done more rapidly than the discharge required for the operation of the motors, a less amount of general machinery is necessary for a given amount of work.

Another and important advantage of the system is the low pressure of the current used to supply the motors, and the consequent increased durability of the motor, and practically absolute safety to life from electrical shock.

It has been demonstrated also that the cars can be easily handled in the street; run at any desired speed, and reversed with far more safety to the armature of the motor than in the direct system. The increased weight requires simply more brake leverage.

The modern battery, improved in many of its details during the last year, is still an unknown quantity as to durability. There is the same doubt concerning this as there was at the time incandescent lamps were first introduced. At that time some phenomenal records were made by lamps grouped with other lamps. Similarly, some plates appeared to be almost indestructible while others, made practically in the same manner, deteriorate within a very short time. It is, consequently, very difficult to exactly and fairly place a limit on the life of the positive plates as yet. Speaking simply from observation of a large number of plates of various kinds, I am inclined to put the limit of about eight months; though it is claimed by some of the more prominent manufacturers—and undoubtedly it is true in special cases—that entire elements have lasted 10 months, and even longer.

It must be remembered however, that the jolting and handling to which these batteries are subjected, in traction work, increases the tendency to disintegrate, buckle and short circuit, and that the record for durability for this application can never be the same as for stationary work. A serious inconvenience to the use of batteries in traction work is the necessary presence of the liquid in the jars. This causes the whole equipment to be somewhat cumbersome, and unless arranged with great care, and with a variety of devices lately designed, a source of considerable annoyance.

The connections between the plates, which formerly gave so much trouble by breaking off, have been perfected so as to prevent this difficulty, and the shape of the jars has been designed to prevent the spilling of the acid while the car is running. The car seats are now practically hermetically sealed, so that the escaping gases are not offensive to the passengers.

The handling of the batteries is an exceedingly important consideration. Many devices have been invented to render this easy and cheap. I have witnessed the changing of batteries in a car, one set being taken out and a charged set replaced by four men in the short space of three minutes. This is accomplished by electrical elevators, which move the batteries opposite the car, and upon the platforms of which the discharged elements are again charged.

The general conclusions which the year's experience and progress have afforded us an opportunity to make, may be summarized as follows:

Storage battery cars are as yet applicable only to those roads which are practically level; where the direct system cannot be used, and where cable traction cannot be used; and applicable to those roads only at about the same cost as horse traction.

I feel justified in making this statement in view of the guarantees which some of the more prominent manufacturers of batteries are willing to enter into, and which practically insure the customer against loss due to the deterioriation of plates; leaving the question of the responsibility of the company the only one for him to look into.

MR. DWIGHT B. DEAN and Miss Mary E. Sisson were married in Chicago on Oct. 7. The wedding took place at the house of the bride's parents, and after the ceremony the happy couple left for the East, where they will spend the honeymoon.

MR. GEORGE ELLSWORTH GALE, for many years connected with the Excelsior Electric Co., of this city, in a confidential capacity, was married Wednesday, Oct. 14, to Miss Edith Mary Clark, daughter of Mr. James T. Clark, of Brooklyn, at St. Mary's Protestant Episcopal Church, in that city.

1. See page 479.

1. Abstract of paper read before the American Street Railway Association, Oct. 23, 1891.

EXHIBITION NOTES.

THE ELECTRIC MERCHANDISE CO., of Chicago, had one of the most interesting exhibits at the convention in Parlor 5. The Burton electric heaters in operation were the rage, and their headquarters were crowded all the time. A fine line of railway material and specialties, comprising rawhide pinions, Chicago trolley clamps, "New Departure" bells, headlights and the new trolley pole and base, the invention of Mr. Elmer A. Sperry, and the new device for holding track brooms were exhibited. Mr. W. R. Mason, the manager of the company, assisted by W. L. Adams, E. H. Englund, F. A. Cicott and D. B. Dean, were kept everlastingly busy explaining the advantages of their railway material and especially the electric heaters. Mr. D. B. Dean in a moment of forgetfulness showed the delegates how to iron silk hats with the Burton heater and after that he had his hands full. He was presented with a trunk for his services in this line by an enthusiast, but when he started to remove it the bottom dropped out and he is still looking for it.

THE FOREST CITY ELECTRIC WORKS, represented by W. B. & G. W. Cleveland, together with the Lieb Machine Works, represented by Mr. Lieb and H. H. Harrison chartered a small "log cabin," facing the hotel on the river front, and made a striking exhibit. Their campaign ticket, "Harrison & Cleveland," attracted much attention. An automatic circuit breaker having many novel and advantageous features, fuse switch for feeder work and dynamo switch were shown by the Forest City Electric Works, and their new "Sandbagger" slow-movement car lighting switch, so called because the arc is smothered by means of fine sand instead of having any form of long-break, quick-movement device, called forth special comment. It was in operation on the 500-volt railway circuit. A non-flashing section switch for cutting out any portion of the line, made on the same principle was also exhibited.

THE SHORT ELECTRIC RAILWAY CO., of Cleveland, covered a large space in the centre of the boat with their exhibit, which comprised a 15 h. p. single-reduction motor, a 25 h. p. waterproof motor and the new gearless motor, which ran perfectly noiseless, and was a special object of attention. A large switchboard of polished oak was shown fitted with switches, circuit-breaker, instruments and the various adjuncts required in the station, and a neatly arranged exhibit of trolley-wire insulators, pull-off brackets, switches, cross-overs and special line tools. A large Short generator in operation, it being driven by a 15 h. p. railway motor, was quite a centre of attraction. The Short Co. also had headquarters in the hotel, in Parlor 11, where their fine catalogue of railway apparatus and the printing matter descriptive of their system was to be found. A beautifully finished car rheostat was on exhibition there.

ALEXANDER BARNEY & CHAPIN, of New York, had a most novel and attractive exhibit, situated directly in front of the ladies' parlor. The A. B. C. railway lamp received considerable attention from the delegates, and the visitors, especially the ladies and children, were infatuated with the "musical" coach and signal trumpet. This alluring siren was worked by the A. B. C. dry battery and manipulated by a 5-point switch. In addition to the above a complete line of railway supplies was shown, including station switches, A. B. C. tape-carbon brushes, fuse wire socket, Alexite cut-outs, and all necessary apparatus for the complete equipment of electric railways. Charles E. Chapin and Henry G. Issertel represented the company, the latter-named gentleman being the musical professor.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING CO., besides their very complete exhibit on the boat and at the hotel, extended an invitation to visit their shops and view their exhibit there. Practical torque tests of the double-reduction, single-reduction and gearless motors were to be seen and all the various parts of the machines and equipment apparatus. The principal and most attractive part, however, of this portion of their exhibit was a 300 h. p. railway generator in operation. The machine shows great beauty of design and absolute sparklessness at the commutator, even when the machine is heavily loaded and then the load suddenly removed by the operation of the automatic circuit breaker. Gearless motors were being turned out in large numbers, and the simplicity of these motors and the excellence of design and workmanship elicited the highest commendation.

THE SOLAR CARBON AND MANUFACTURING CO., of Pittsburgh, Pa., exhibited a very handsome line of carbon products. In addition to ordinary arc light carbons a number of specialties in this line were shown, among them a new carbon trolley wheel having metal flanges and carbon sheave or wheel. Their new soft-cored carbons specially adapted for arc lamps running on incandescent circuits are to be seen in practical operation in the Ward arc lamps. The mammoth carbons for aluminum smelting were also to be seen, and circular carbons for use in lightning arresters. A A pretty souvenir in the shape of a carbon medal was distributed by this company. Mr. Laughlin and Mr. Webb were on hand to show their products.

THE ELECTRICAL SUPPLY CO.'S exhibit, shown in Parlor 37, was complete in every detail, and of great interest to electric railway men on account of the many new devices, improvements on old ones, shown. Some of the new articles might be briefly described as follows: Trolley wire hangers so formed that it is impossible for them to drop the trolley wire.

A reliable pole ratchet that can be sold at a low price.

A trolley catcher that pulls down the trolley pole as soon as the wheel jumps the trolley wire, and holds it out of harm's way till adjusted.

Improvements in anchor plates.

A strain insulator, guaranteed to insulate and to stand a strain of 6,000 pounds.

The Wirt volt and ampere indicators.

Sunbeam railway lamps.

The Reed oil feeder for trolley wheels.

Ward's connector for lighting trailer cars.

Ward's duplex fuse box.

In addition to numerous other specialties, the Electrical Supply Co. placed on exhibit some very handsome reels of Habirshaw wire, Shield brand wire and magnet wire.

THE EDISON GENERAL ELECTRIC CO. occupied a large parlor on the ground floor of the hotel, and had a comprehensive and beautifully arranged exhibit. The lighting effects by means of various colored miniature incandescent lamps were excessively striking in appearance. Over the entrance to their parlor was a monogram formed of these lamps and inside the words, "Edison General Electric Company." A No. 13 Brill truck equipped with two 15 h. p. single reduction-motors was in operation, run from the hotel lighting plant. A handsome controlling stand, of colored marble fitted with special new switches, and measuring instruments, etc., was placed on one side of the room. Artistic lighting fixtures were displayed, showing the beauty and finish which has been attained in this line.

THE THOMSON-HOUSTON ELECTRIC CO., in addition to their exhibit on the "J. M. Gusky," had a handsome suite of parlors in the hotel, where they entertained their many friends, and also had an attractive exhibit in the shape of a large board containing samples of their appliances for overhead railway construction situated in the hall on the second floor of the hotel, and also had an imposing array of catalogues and printed matter descriptive of their system, which rapidly vanished, so interested were the delegates in their products. The company also distributed copies of THE ELECTRICAL ENGINEER of Oct. 21, containing Mr. A. C. Shaw's article on the West End road.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING CO. made a striking display of their motor equipments, etc., on the barge. An ordinary standard single-reduction motor immersed in a tank of water and run from the street railway circuit attracted a great deal of attention. They also had a Hubbard truck equipped with two single-reduction 20 h. p. motors and a Gilbert truck fitted with two of their new "Gearless" motors, a sample switchboard furnished with circuit breaker, ammeters and voltmeter, lightning arrester, switches and resistance box, and a full line of detail parts of their system, showing the working of the various parts and making a highly interesting exhibit,

THE WIGHTMAN ELECTRIC MANUFACTURING CO., of Scranton, Pa., showed a truck equipped with two 20 h. p. single-reduction Wightman motors, and their special controlling switch. On a sample board they also had a complete outfit of line material. Their new trolley and base were also shown. The truck was manufactured by Dorner & Dalton, of Cleveland, O., and is known as the Du Pont truck. H. Bergohltz, M. Wightman and P. D. Nicholl were in attendance, and the exhibit was in charge of D. F. Kennedy.

THE THOMSON-HOUSTON ELECTRIC CO., of Boston, showed a fine line of their standard electrical equipments, occupying the lower end of the boat. Amongst the apparatus exhibited was a 15 h. p. double-reduction a 15 h. p. single-reduction, and a 15 h. p. double-reduction, adapted for use on narrow-guage railroads. A handsome polished slate switchboard was equipped with the various switches, automatic circuit breakers, instruments, etc. The trolley and rheostats of this system were also shown.

THE CHAS. MUNSON BELTING CO. made a handsome display with a 48 inch belt 110 feet long for main driving belt, and two generator belts each 22 inches wide and 50 feet long. These belts were manufactured for the Birmingham Traction Co. This company have also furnished belting for the Pleasant Valley road and the Duquesne Traction Co., there being in use on each road two 48-inch belts 135 feet long. Col. J. H. Shay, a noted figure at street railway conventions, and N. H. Byam, looked after the company's interests.

THE ELECTRIC CONSTRUCTION AND SUPPLY CO., of New York, made a very practical display of the widely known Ward arc lamps, 10 of these being run in series on the exhibition boat from the street railway current. They burn with a clear, steady arc, and at night made a most attractive sight. R. B. Corey and J. C. Knight were in attendance.

THE REVERE RUBBER CO., of Boston, Mass., exhibited their new flexible conducting "Flexite" for use in place of hard rubber, and especially for conduit service in buildings and cars; also their trolley insulator compound belts which are unbreakable under ordinary use. A fine sample board set off their parlor to advantage; friction tape, rubber belting, packing, and steel wire wrapped hose formed a pleasing combination. The glass paper weight souvenir and calendar presented by the Messrs. Ellicott & Chaney, of the company, were eagerly sought after.

THE CARPENTER ELECTRIC HEATING MANUFACTURING CO., of St. Paul, Minn., showed their electrical heating apparatus, which comprised their new car heaters, sad irons, etc. The electric car heater exhibited by this company consists of a plate of cast iron, to one side of which the resistance wires are attached, being insulated and embeded in a coating of emanel. Mr. Carpenter was in attendance explaining his heating apparatus.

THE WESTERN ELECTRIC CO. had headquarters in Parlor 34, where they exhibited a very complete line of supply material for all kind of uses electrical, manufactured by the company. Among their specialties was shown a new trolley wire clamp. Some fine samples of trolley and feeder wire switches, and railroad lamps were exhibited. The company was ably represented by E. W. Bennett, M. B. Austin and S. A. Chase.

THE CALORIFIC VENTILATING HEATER CO. showed a number of their heating services in Parlor 3. It formed an exhibit of great interest. Three different styles of heaters were shown. The "Calorific" is fed with coal from the inside and the ashes removed from the outside, and maintains a uniform temperature in all parts of the car without overheating in the vicinity of the stove.

THE MITCHELL BRANT COPPER CO., of Erie, Pa., showed a line of tempered copper commutator strips in Parlor 5. Mr. Daniels was kept busy explaining the advantages of their product, and the samples he exhibited were perfect and fitted together just as they are cast, like fine clockwork. This copper is exceptionally pure and of the very highest electrical conductivity.

THE J. G. BRILL CO., of Philadelphia, made a very fine exhibit in Parlor 11, of models of their several styles of trucks, and also had one of their latest trucks, forming a part of the Edison exhibit. They also had a 25-foot double-truck car on exhibition on Water street, and an 18-foot car equipped with Short gearless motor running on the streets.

THE LIEB MACHINE WORKS had a complete outfit of overhead equipment material, including their new trolley hangers with mechanical clip and molded asbestos, bell insulators, trolleys with bearing in the fork instead of the wheel, as in most forms, strain insulators, etc. A small Lieb fan motor, of which a large number have been sold during the last summer, was shown.

PIERCE BROS. & CO., of Leominster, Mass., made a fine display of overhead appliances for electric railway construction, comprising single and double pull overs, bracket-arms, cross-overs, insulated crossings, span holders etc. They also exhibited a portable railroad machine to take the place of a ratchet drill and having an emery drill grinding device.

THE GOULD & WATSON CO., of Boston, showed their mouled mica insulators in all kinds of shapes and sizes. This material has been very widely used in electric street railway work, and the exhibit in the hall leading to the meeting room was so much studied as to be an innocent cause of blockade all the time.

PARTRIDGE CARBON CO., of Sandusky, O., made a large display of their carbon brushes in Parlor 5. They have acquired quite a reputation for these goods, especially due to the fine lubricating qualities of their carbon and the excellent shape in which they maintain the commutator.

THE LEWIS & FOWLER GIRDER RAIL CO., of Brooklyn, made a fine display of girder rails on the second floor of the hotel, and also exhibited their fare registers, which are so widely used. As usual they ran a special train to bring their many friends to the convention.

THE ENGINEERING EQUIPMENT CO., of New York and Boston, showed a very complete line of street railway equipment, notable among their specialties being the Anderson Ætna insulators and the Boston trolley. They had their exhibit on the steamer "Mayflower," which was moored just below the boat "J. M. Gusky."

BENEDICT & BURNHAM MANUFACTURING CO., of Waterbury, Conn., were represented by E. H. OSWALD, who exhibited some neat reels of hard drawn copper trolley wire, insulated feed wire and magnet wires. Some handsome leather wire cards were given away as souvenirs by Mr. Oswald.

THE JOHNSON CO., of Johnstown, Pa., had an exhibit of their various types of girder rails on board the "Mayflower," including slot rails and sections showing method of making crossings. Samples of Johnson girder rails were also placed on the sidewalk in front of the hotel.

THE UNITED STATES GRAPHITE CO., of Saginaw, Mich., were represented by Mr. W. G. Wilmot, who exhibited their Sonora graphite specialties. This lubricant is especially adapted for motors, gearings, and other bearings for street railways.

POST & CO., of Cincinnati, had a very attractive exhibit of street railway specialties and fixtures in the hall on the 2d floor of the hotel, and Mr. I. Kensey was kept busy explaining the merits of his many valuable devices.

THE NEW YORK CAR WHEEL WORKS had an artistically arranged space, with floral decoration around their comprehensive exhibit of machined street car wheels, manufactured from the very best charcoal iron.

THE TRIPP MANUFACTURING CO., of Boston, exhibited their roller bearings for car axles, which are in extended use, and a trolley equipped with similar bearings. A special piston packing also formed a part of their exhibit.

THE ROCHESTER CAR WHEEL WORKS, of Rochester, N. Y., exhibited a number of street car wheels of various sizes. A Barr contracting chill employed in the manufacture of these wheels composed a part of this exhibit.

THE STANDARD UNDERGROUND CABLE CO. exhibited lead-covered cable for use underground, and their well-known wires for overhead and feeder work. They made a neat and handsome display of their products.

THE R. B. NUTTALL CO. made a splendid show with their raw-hide pinions, gear wheels, steel pinions, and other electric railway specialties. Mr. Nuttall, Mr. Mayer and Mr. Manning were in attendance.

THE ROBINSON MACHINE CO., of Bellwood, Pa., had a Robinson Electric motor truck on exhibition entirely made of steel, with 30-inch wheels, combining great strength and durability with simplicity.

THE BALTIMORE CAR WHEEL CO., of Baltimore, Md., had a new pattern truck on exhibition. It is fitted with a special form of brake and oil and dust proof bearings and fitted with 36-inch wheels.

THE PECKHAM MOTOR TRUCK & WHEEL CO. had a single side frame of the cantilever pattern on exhibition, and Mr. Peckham was in attendance. They also showed a radial geared cantilever truck.

THE H. M. LOUD & SONS LUMBER CO., of Oscoda, Mich, exhibited their octagonal poles for railway and electric light work, and were represented by G. H. Keating, of Bay City, Mich.

THE EDISON GENERAL ELECTRIC CO. had headquarters for their intelligence department in Parlor 160, where Mr. M. J. Suilivan, the representative of this department, was to be found.

JOHN WHITE, of Allegheny, showed a full line of his famous "baked wood" insulators for trolley and feed wires, etc., and also many novelties for use in electric railway construction.

JOHN H. GRAHAM & CO., of N. Y., exhibited a number of the New Departure platform alarm bells. These bells were also shown by the Electric Merchandise Co., in Parlor 5.

THE MORTON SAFETY HEATER CO. made an attractive exhibit on board the "Mayflower" of their system of heating street cars, by storing heat in earthenware tubes.

THE WALKER MANUFACTURING CO., of Cleveland, O., made a prominent display of photographs and a working model of the Walker differential cable drum.

THE HILL CLUTCH WORKS had a plentiful supply of photographs and literature regarding the famous Hill clutches and devices for power transmissions.

THE BODIFIELD BELTING CO., of Cleveland, O., showed a 25-inch double belt, a 48-inch and an 8-inch dynamo belt and a 24-inch heavy double belt.

THE BROWNELL CAR CO., of St. Louis, exhibited outside the hotel their new accelerator car, which possesses many novel points in construction.

BRYANT & BARBEY, of Boston, made a display consisting of a portable rail saw for cutting rails without removal from the ties.

THE EASTERN ELECTRICAL SUPPLY CO., of Boston, showed a fine line of overhead railway appliances and other specialties.

THE RELIANCE GAUGE CO, of Cleveland, had a good display of their popular safety water columns and other steam fittings.

A. WHITNEY & SONS made an exhibit of chilled car wheels, both in the rough and bored, and mounted.

THE PENNSYLVANIA STEEL CO. exhibited frogs and fastenings and several styles of girder and tee rails.

THE HALE & KILBURN MANUFACTURING CO., of Philadelphia, made an attractive display of car seats.

J. H. BUNNELL & Co., of New York, did not make any exhibit, but they were, as usual, keenly alive to the situation as shown by the presence of Mr. C. McLaughlin and Mr. J. J. Ghegan, who took in everything in a very quiet, but expert and critical fashion. Mr. McLaughlin, who is an old steam railroad man, is now actively interested in one of the larger electric roads in New Jersey.

WESTINGHOUSE, CHURCH, KERR & Co. were represented by Mr. A. C. Kerr, whose recent Franklin Institute talk on the steam loop is one of the most valuable of recent contributions to steam literature. It is now obtainable in pamphlet form. The concern had also some other pamphlets for distribution, of great utility.

JOHN A. ROEBLING'S SONS CO., had a good exhibit, and were well represented by Messrs. Shippy, Bailey and others. They have the peculiar advantage of being on both sides of the fence at once. If a man decides to put in a cable plant, they sell him the wire rope; if electric, they sell him the wire.

THE STREET RAILWAY JOURNAL, in spite of great difficulties caused by the local printers' strike, managed to issue a most creditable daily bulletin of no less than 20 pages. It was represented by Messrs. McGraw, Fairchild, Blake, Stump, and others of its staff.

THE NATIONAL CONDUIT MAFUFACTURING CO., of New York, were represented by Mr. J. P. McQuaid, who had with him some very interesting photos showing curves of very short radius in some new underground work, using their cement-lined iron pipe.

THE AMERICAN ELECTRICAL WORKS issued several additions to its Comic Library, and all were eagerly sought after. Perhaps the pack of playing cards was the most successful of these amusing publications. Mr. P. C. Ackerman acted as colporteur.

THE UNIVERSAL ELECTRIC CONSTRUCTION CO., of Philadelphia, made an exhibit of their "friction clutch," the object of which is protect street car armatures. They have also brought out a new form of armature, for which many merits are claimed.

THE DUPLEX STREET RAILWAY TRACK CO., of 51 Wall street, New York, made an exhibit of their ingenious rail by which continuity of the ground return is maintained, obviating the necessity of rail bonds. It has been desribed in these columns.

MR. H. W. SMITH, of the Smith Electric Conduit Co., distributed modest brochures relative to his solution of the conduit problem. His plan is an ingenious one and he is quite sanguine as to its ultimate adoption and success.

THE ENGINEERING EQUIPMENT CO. were early on the ground and stayed late, Mr. W. F. D. Crane being their representative. They had a great many specialties, such as Kellogg poles, Underwood cotton belting, etc.

THE SIMPLEX ELECTRICAL CO., of Boston, were present to advocate and demonstrate the merits of their wire for railway work. Mr. W. H. Gordon was also present to speak for this specialty.

THE FORT WAYNE ELECTRIC CO. has not yet cut much figure in the electric railway world, but it is already in line, and was represented at the convention by Mr. W. R. Kimball.

THE INTERNATIONAL OKONITE CO. was well represented, not only by its various selling agencies, but by Capt. W. L. Candee and Mr. T. McCoubray.

MR. VAN NUIS, of Ajax switch fame, carried his new "Fulmen" lightning arrester as a watch-charm. Every one who saw it pronounced it a "corker."

THE BENEDICT & BURNHAM CO., of New York and Waterbury, made a good display of their electric wires, etc., through Mr. D. L. Hungerford.

THE JEWELL BELTING CO., of Hartford, Conn., showed a 48-inch double belt manufactured for the Toledo Electric Street Railway Co.

THE PULLMAN PALACE CAR CO., which is now putting so many electric car bodies into active work, was represented by Mr. W. S. Loutitt.

THE FIELD ENGINEERING CO. was present in the person of Mr. C. J. Field, who has done so much in electric railway construction work.

HOLMES, BOOTH & HAYDENS, of New York, were represented by Mr. Lafayette Cole, who spoke for their specialties in insulated wire, etc.

THE BROOKLYN RAILWAY CO., of New York, exhibited a "Walk-away" snow plough of the road scraper pattern for two or more horses.

THE MCCONWAY & TORLEY CO., of Pittsburgh, showed a line of rail joints.

THE ELECTRICAL SUPPLY CO'S SOUVENIR BADGE proved extremely popular, and as much disappointment was expressed by railway men who were not fortunate enough to procure one before the supply was exhausted, the Electrical Supply Company has promised to have some more made and forwarded to all electric railway men who write for them.

MR. F. MANSFIELD exhibited his new electric city tramway system, which consists of a new form of underground working by means of a guide slot construction, the circuit being made above ground and without the use of a conduit proper, a shallow box-lid arrangement being used instead and containing the contact-making mechanism.

JOHN R FLETCHER'S Dayton arc light cut-out was exhibited by the Electrical Supply Co. The advantages gained by using this invention are too apparent to practical men to need any extended notice. Full particulars can be obtained by addressing the Electrical Supply Co., Chicago, or John R. Fletcher, Dayton, Ohio.

THE DETROIT ELECTRICAL WORKS showed a very beautiful model of their railway system, and were represented by Mr. Louis Warfield, Mr. C. A. Benton and Mr. Frank Rae. Cars equipped with their motors were running on the streets, and they consider this the best kind of an exhibit.

THE INTERIOR CONDUIT AND INSULATION CO., of New York, exhibited a section of their underground conduit. This conduit is used for drawing-in bare conductors, and has won notable success in the street railway lines of Minneapolis and St. Paul.

THE EQUITABLE ENGINEERING & CONSTRUCTION CO., of Philadelphia, showed a line of centre curve insulators, trolley wire joints, line insulators, pole ratchets, and all necessary appliances for overhead electric railway construction.

WM. H. WESTON, of Philadelphia, made a handsome display. Among the specialties shown was a quick-break railroad switch of 800 amperes capacity, and several knife switches. Mr. E. Plowman was in attendance.

THE PITTSBURGH STEEL HOLLOW WARE CO., made a good display of their rolled steel bells and gongs, which are made by an entirely new process and are remarkable for tone and durability.

THE JOHNSTON SAFE AUTOMATIC ELECTRIC DISCONNETOR CO. showed their new automatic disconnector in operation. It is an excellent device and will no doubt be widely used.

CHAS. A. SCHIEREN & CO., of New York, made a comprehensive exhibit of perforated and link belting. Mr. E. P. Atkinson and Mr. G. H. Fisher represented the company.

WALLACE & SONS, of New York, represented by Mr. James Goldmark, made an attractive display of hard drawn copper trolley wire.

THE WASHBURN & MOEN CO., Worcester, showed a fine lot of samples of trolley wires, steel railway cables and bare copper wires.

THE SCHNEIDER COMBINATION CAR CO., of Chicago, had some very handsome models of combination summer and winter cars.

WM. GARDAM & SON, the well-known electrical model makers of New York, were represented by Mr. J. Gardam.

THE BALL ENGINE CO., of Erie, Pa., showed photographs and wood cuts illustrative of their well-known engines.

THE P. & B. INSULATING PAINT CO., of New York, made a fine show of their various P. & B. specialties.

THE PITTSBURGH TROLLEY CO., a new and pushing concern, were represented by Mr. J. S. McCormick.

THE ALUMINUM BRASS AND BRONZE CO., of Bridgeport, Conn., were represented by Mr. J. H. Conkling.

THE P. WALL MANUFACTURING SUPPLY CO., of Allegheny City, showed their forged steel car gongs.

THE GISHOLT MACHINE CO., of Madison, Wis., showed their "Renewable Rim" motor gears.

MR. JARVIS B. EDSON exhibited at the Duquesne Hotel one of his recording registers for steam.

THE GENETT AIR BRAKE CO. exhibited the Genett air brake.

THE MEAKER MANUFACTURING CO., Chicago, had a very complete exhibit of fare registers.

THE AMERICAN TUBE & IRON CO., of Pittsburgh, exhibited their electric railway trolley pole.

THE BRIDGEPORT BRASS AND COPPER CO. had a pleasing exhibit of feeder and trolley wires.

THE ELECTRICAL ENGINEER made its headquarters in parlor 5 and was represented by Messrs. T. C. Martin and W. F. Collins. So many applications were received for its issue containing the West End article that a large edition was completely exhausted by Thursday forenoon.

NOT A FEW notable electricians and manufacturers of the earlier day were to be noted in the crowd. Among them may be mentioned Mr. H. Ward Leonard, Prof. W. A. Anthony, Prof. D. C. Jackson, Mr. J. B. Wallace, and Mr. W. Baxter. The last named is working hard again at electric railway problems.

"ELECTRICITY."

It is announced that Messrs. Dickerson and Washington have resigned their respective positions on the new Chicago journal *Electricity*. Mr. Dickerson has a great many friends in the electrical field, to whom the news of his recent severe illness has been a shock, but they will be glad to learn that he is on the high road to complete recovery, and will soon be among them again. He has been succeeded in his editorial duties by Mr. H. L. Webb, who is well known by his various contributions to the electrical journals, and probably best by his recent articles in our columns on the testing of wires and cables, now about to issue in book form.

Society and Club Notes.

THE ELECTRIC CLUB.

The Electric Club will have a most enjoyable time on Thursday evening, when it will celebrate a Warzburger Nacht. The Entertainment Committee have kept very quiet about the details of this, and hence have piqued curiosity. It is confidently expected to be one of *the* nights of the year.

MR. F. V. HENSHAW BEFORE THE BROOKLYN INSTITUTE ON ELECTRIC MOTORS.

The first meeting of the season of the Electrical Section of the Brooklyn Institute was held in the hall of the Y. M. C. A. of that city at 8 P. M. Oct 16. President James Hamblet made a few remarks upon the very interesting meeting held in conjunction with the American Institute of Electrical Engineers at Columbia College, where they listened to Mr. Nikola Tesla on the subject of incandescent lighting by his new induction system of high frequencies. Mr. Hamblet then introduced the lecturer of the evening, Mr. F. V. Henshaw, electrician of the C. & C. Motor Company.

Mr. Henshaw began by comparing the magnetic circuit of the motor, its properties and analogies, to that of the electric circuit, illustrating his remarks by diagrams on the blackboard, showing the different forms of fields, beginning with the two-pole Edison type. He illustrated successively the double-circuit curved-magnet type of the well-known C. & C. motors, the Manchester dynamo, the ironclad, and various others. It was then explained how the entire action of the motor depended upon the relationship between the strengths of the two magnets constituted by the fields and the armature. Attention was called to the differences between ring and drum types of armatures, and to the superior copper economy of the drum, and to the fact that the air-gap with that type could be made much less than with the other, owing to the fact that after being built up the armature could be turned off in a lathe; while the chief advantage claimed for the ring was slow speed and better insulation. Mr. Henshaw then took up the question of design, prefacing his explanation with the remark that many who understood quite thoroughly the various questions involved were often at a loss where to make a starting point in planning a motor for any given set of conditions. Where the motor is to be operated on a constant-current circuit it was shown that the horse-power at once determined the E. M. F., while, if for use with constant potential, the power to be developed at once gave the amount of current. It was also pointed out that a constant-current motor could not be "wound" for automatic regulation, but required a mechanical governor to control the counter E. M. F., which would otherwise tend to rise until it equaled that of the generator, were the mechanical strength of the motor sufficient to allow so great a speed to be attained without flying to pieces. The general current equation was given as $C = \frac{\text{H. P. } 746}{\text{E}}$. Shunt, series and compound windings were explained and their special adaptability for particular applications. For instance, the shunt type, where constancy of speed was desired, or the series, where the load was constant, as in operating a ventilating fan, or where torque was of importance, as in the case of street railway motors. When considering the efficiency of a motor it was shown that the efficiency would be 100 per cent. when the counter E. M. F. was equal to that of the current supplied the motor, in which case its current would be zero, and showed therefore that the aim, so far as efficiency was concerned, was to get the equality between these two electromotive forces as near as possible. The number of turns on the armature was to be made as great as possible in order to produce a maximum of E. M. F.; while on the other hand this introduced resistance, and these two conflicting conditions ought to be equalized according to other factors. The question of heating in the armature coils, as is true also of fields, was shown to depend not so much on the surface of the wire, but on the amount of exterior surface of the armature or coil as a whole. As a general rule, with coils in depth from 1 to 1¼ inches; 2 square inches per watt was a fair figure for temperature of 60° C. The purpose of making the resistance of a shunt motor as high as possible was shown to be merely that of cutting down the amount of current for producing the same amount of field strength. With regard to operating machines where the heating was very great, it was pointed out that the increase of temperature above that of the surrounding air was the question to be looked at rather than the absolute amount of heat being generated in the coils. For instance, a motor and dynamo creating an absolute amount of heat might become very much hotter without danger were it situated in an engine-room where the temperature was 120° than one where the air was very much cooler. A temperature from 40° to 60° above that of the surrounding atmosphere was not to be exceeded under ordinary circumstances, although such difference might be reached for a short time without absolute danger to the insulation. With regard to the question of sparking, diagrams were drawn to show the greater twisting of the force lines out of their normal paths from pole to pole when the load on the armature was large, and how these lines' shrunk back again into place as the armature current fell. The question of air space was considered with regard to the difference in its effect in large and small motors, the limits between which it would be reduced being very small in the latter case. With regard to the term, magnetic resistance, it was shown that the magnetic resistance of a circuit varied, while that of the electric circuit was a constant quantity. With regard to the proper velocity of inductors (armature wires) it was shown that the best results were found in actual practice when such speed was from 40 to 50 feet per second, The speed and work being given determined the armature diameter. The efficiency gave at once the amount of waste energy to be divided between the losses in the field and armature, which, in motors ranging between one and 100 H. P, would be in the field from 10 to 2 per cent., and in the armature 12 to 4 per cent. approximately. The diameter of the armature and the amount of heat would at once limit its length, which, for a drum armature, should be such as to provide so much surface as to allow of not more than one watt per square inch. The air gap then gave the attainable field strength; from the field strength and the speed the armature turns would be had, and the size of armature being given, therefore its resistance, and from that the size of wire was found. The magnetic resistance was dependent upon the loss allowed in the field. The cross-section of the magnets depended on their material, whether wrought or cast iron, and also on the particular qualities of the special iron used. For wrought iron from 10,000 to 15,000 lines per square centimetre were allowable; for cast, only 4,000 to 7,000. The formulæ for the magnetic resistance was given as follows:

$$\text{Iron Mg. R.} = \frac{L}{\eta A}$$

or length divided by the area into a constant, best determined by actual test of the particular iron to be used; and it was shown that one difficulty in treating the magnetic circuit was due to the fact that it usually contained not only air, but iron of two different kinds. The area of the pole pieces, with regard to the armature, was considered in some detail, showing the danger from leakage in the way of short circuiting of the magnetic lines, where the arc of the pole was made too great. This was illustrated with diagrams of various types of motors, and the general principle was stated that not over 80 per cent. of the circumference of the armature should be embraced by the pole pieces; that for two-pole machines the arc was usually made about 135°, and that it was found, where they approach nearer than this, sparking would be produced at the brushes. The relative advantages of multipolar motors were considered, and, time being short, the lecture closed with the operation of a two-horse power C. & C. standard motor, together with the exhibition of different parts, such as brushes, commutators, segments, etc. It had been Mr. Henshaw's intention to illustrate the lecture with some induction experiments, but, unfortunately, through some mistake, the apparatus was not taken over to the hall.

Mr. J. Stanford Brown remarked that, probably, no one present could fully appreciate the value of the lecture to which they had just listened, who had not been called upon to attempt the design of a commercial machine, and he also claimed that the slur could no longer be made upon American electricians that they were designing machinery by the old "rule of thumb methods, so prevalent up to the last year or so.

Mr. Charles D. Emery, president of the engineering section of the Institute, then rose, and, after complimenting Mr. Henshaw on his avoidance of intricate technicalities, and his having interwoven with his outline facts of great practical value, moved a vote of thanks, after the adoption of which the meeting adjourned.

Mr. F. H. Sparling, late of W. H. Gordon & Co., has been appointed New York State agent for John A. Roebling's Sons Co., for electrical work.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED OCTOBER 13, 1891.

Alarms and Signals:—

Circuit Connector for Electric Signaling Apparatus, W. L. Gates, 461,075. Filed July 19, 1889.

Electric Signaling Apparatus, E. G. Mettler, 461,104. Filed Oct. 15, 1890.
Adapted to give notice of the breaking of wires arising from over-heating or burning-out.

Non-Interfering Fire-Alarm Box, F. F. Loomis, 461,169. Filed May 1, 1891.

Electric Boiler-Alarm, M. Beckers, 461,178. Filed Dec. 24, 1889.
For signaling the level of water in a boiler.

Signaling Switch and Circuit, J. W. Stover, 461,194. Filed May 29, 1891.
Adapted for police and fire-alarm systems.

Fire-Alarm Apparatus, W. C. Shaffer, 461,371. Filed Dec. 14, 1888.

Clocks:—

Combined Electric Clock and Thermoscope System, H. J. Haight, 460,963. Filed Mar. 7, 1887.
Patented in Great Britain Mar. 10, 1887, No. 4,135 A.

Conductors, Conduits and Insulators:—

Device for Stretching Heavy Wires on Poles, H. P. Ball, 461,109. Filed Mar. 21, 1891.

Connection for Electric Conductors, J. Dillon, 461,195 Filed May 13, 1891.

Electric Conductor, F. A. Perret, 461,272. Filed May 21, 1889.
Employs as an insulating compound collodion and glycerine or a solution of a natural gum and glycerine in collodion; the solution is used in connection with a fibrous covering.

Distribution:—

Electric Inductional Transformer, W. Stanley, Jr., 461,135. Filed Jan. 16, 1891.
Claim 1 follows:
A sectional transformer-core composed of detached plates or groups of plates held loosely in their supports, so as to be capable of mutually independent self-adjustment in planes substantially parallel with their respective surfaces.

System of Distributing Electric Energy, R. Kennedy, 461,139. Filed Sept. 24, 1890.
Claim 1 follows:
In a system of electrical distribution, two armature-windings which alternately traverse the same or similar magnetic fields, whereby alternating electrical pulsations of unlike phases are induced in the respective windings, in combination with independent pairs of main conductors, independent commutators whereby the alternating pulsations induced in the respective windings are rectified before traversing the respective pairs of main conductors; a conductor directly uniting one positive brush of one with one negative brush of the other of said commutators, and translating devices connected between the conductor connected with the other positive brush of one pair and the conductor connected with the other negative brush of the other pair of said mains, substantially as set forth.

Dynamos and Motors:—

Rheostat, O. A. Kessner, 460,972. Filed March 18, 1891.
A rheostatic switch for regulating shunt wound dynamos.

Electro-Magnetic Brake, A. J. Shaw, 461,052. Filed July 2, 1891.
Adapted to bring a motor, or machinery driven by it, to a stand-still immediately upon the interruption of the working current.

Commutator-Oiler, F. L. McGahan, 461,105. Filed Nov. 7, 1890.

Dynamo-Electric Machine for Alternating Currents, R. Kennedy, 461,140. Filed Oct. 30, 1890.
Claim 1 follows:
In a dynamo-electric machine or motor, the combination of a field-magnet having multiple poles disposed in two groups of opposite polarities, each of said groups being composed of a plurality of radial polar extensions, two annular laminated armatures having a radial thickness not less than the breadth of the faces of the radial poles, and a cylindrical iron shell inclosing and supporting said armatures and serving to concentrate the magnetic lines.

Dynamo-Electric Machine, E. T. Gilliland, 461,240. Filed Jan. 31, 1891.
A design and construction of frame and pole-pieces intended for facility of manufacture and assembling.

Armature for Electric Motors, C. J. Van Depoele, 461,296. Filed April 7, 1891.
Claim 1 follows:
In an electro-dynamic motor, an armature the sections of which are spaced by separating blocks or strips and which is enveloped by an exterior winding or covering also of magnetic metal.

Actuating Device for Moving Commutator-Brushes, C. J. Van Depoele, 461,297. Filed May 20, 1891.
Employs frictional connections between the commutator and contact devices, a detent holding the contact carrier, and means for periodically retracting the detent.

Galvanic and Thermo-Electric Batteries:—

Electric Battery, D. M. Lamb, 461,023. Filed Dec. 7, 1889.
Employs granular active material having each granule enveloped in a water-repellent substance.

Composition for Electric Batteries, D. M. Lamb, 461,024. Filed April. 10, 1890.
Employs pulverized clay and calcined gypsum in combination with the active material.

Electric Battery, D. M. Lamb, 461,025. Filed July 23, 1890.

Compound for Electric Batteries and Method of Preparing the Same, D. M. Lamb, 461,026. Filed May 26, 1891.
Prepares active material by coating each separate granule with water-repellent material and then mixing the coated material with other ingredients.

Electric Battery, D. M. Lamb, 461,027. Filed May 26, 1891.

Galvanic Battery, P. Hieronymus, 461,262. Filed Feb. 12, 1891.
Uses a partition held a short distance above the bottom of the jar; elements rest on the partition; employs a wick for conducting water from the lower part of the jar to the elements.

Lamps and Appurtenances:—

Fuse-Box for Electric Lamps, A. B. Holmes and G. F. Gale, 460,968. Filed April 15, 1890.

Incandescent Electric Lamp, A. L. Reinmann, 460,991. Filed Feb. 11, 1891.
Relates to sealing-in conducting wires and is designed to save in the cost of platinum.

Electric Arc Lamp, E. Thomson, 461,144. Filed June 14, 1890.
Claim 1 follows:
The combination, in an electric arc lamp, of a positive feed-gear, such as a worm and screw, a pivoted frame sustaining one member of the gear and the carbon carrier connected with said member, an electromagnet for actuating said frame to bring the two members of the gear into engagement and form the arc, and a derived circuit actuating magnet for operating the other member of the gear to cause a feed of the carbon.

Measurement:—

Electric Meter, G. R. Baldwin, 461,229. Filed Nov. 20, 1890.
Claim 1 follows:
In an electric meter, the combination of a lever, an adjustable fulcrum for said lever, a current-indicating device which controls said fulcrum, a rigid backing-piece by which said adjustable fulcrum is supported when the lever is forced down upon it, a registering device, and a clockwork, each connected to said lever.

Metallurgical:—

Electro-Magnetic Separator, G. M. Gouyard, 460,962. Filed Jan. 6, 1891.

Miscellaneous:—

Electric Soldering Iron, W. Mitchell, 460,978. Filed Jan. 9, 1891.

Electric Soda Fountain, W. Mitchell, 460,979. Filed Feb. 9, 1891.

Electric Heating Core for Smoothing Irons, W. Mitchell, 460,980. Filed March 24, 1891.

Electric Parlor Game, W. L. Gates, 461,076. Filed July 19, 1889.

Electrical Automatic Fire-Extinguisher for Buildings, W. H. Soley, 461,087. Filed Jan. 17, 1889.
Electro-magnetic valve-opening devices.

Fire-Extinguisher, J. Wolstencroft and W. H. Soley, 461,089. Filed Feb. 1, 1889.
Thermostat and electro-magnetic controlling devices.

Electric Door-Operating Device, R. F. Troy, 461,122. Filed Sept. 18, 1890.

Switch Box, H. A. Foster, 461,239. Filed Oct. 24, 1890.
Designed to secure the exclusion of moisture and thorough insulation while furnishing facilities for the ready operation of the switch and access to the interior of the box.

Watchman's Electric Time Recorder, F. W. Schiefer, 461,279. Filed April 15, 1891.

Automatic Electric Pump, C. J. Van Depoele, 461,294. Filed Feb. 26, 1891.
Application of a reciprocating electric motor.

Electrically-Actuated Pump, C. J. Van Depoele, 461,295. Filed March 27, 1891.
Employs a reciprocating motor.

Electric Switch, S. P. Van Nort, 461,298. Filed Nov. 21, 1890.
A continuity-preserving switch.

Railways and Appliances:—

Trolley-Catcher for Electric Cars, W. L. Browne, 460,942. Filed June 26, 1891.

Electric Signal for Railway Trains, L. Dunn, 460,958. Filed Feb. 18, 1891.
For signaling from one part of a train to another. Designed to supersede bell-ropes.

Track Rail for Electric Street Railways, J. T. Hill & B. Meiring, 460,967. Filed Dec. 29, 1890.

Electric Railway, B. R. Shover & W. C. Dickson, 461,057. Filed Feb. 25, 1891.
An induction system, precluding the necessity of contact with the supply conductor.

Electric Car Motor, G. Willett, 461,228. Filed Dec. 22, 1890.
Armature shaft arranged longitudinally of the car; employs worm gearing.

Motor Truck, C. J. Van Depoele, 461,293. Filed Sept. 25, 1889.
Claim 1 follows:
The combination of a spring-supported truck-frame adapted to sustain the car-body, a secondary frame depending therefrom, one or more motors sustained at one end upon the truck axle or axles independent of the springs, and yielding connections between the free ends of the motor or motors and the secondary frame.

Telegraphs:—

Telautograph, M. Soblik, 461,152. Filed March 23, 1891.
Operates by means of variations in the resistance of the main circuit.

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, *150 Broadway, New York city.*

THE ROBERTS CHROME ARC LIGHT PENCIL.

IN my article in THE ELECTRICAL ENGINEER of Oct. 14, on Chrome Arc Light Pencils, a mistake was made in saying that "some changes must be made in this pencil before it can be used." It should have read, "Some changes must be made in the lamps now in use before this pencil can be properly used."

These changes are only slight, and when made will enable this pencil to be used in connection with any sytem.

NEW YORK, Oct. 20th, 1891. ISAIAH L. ROBERTS.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Modern advertising is the creation of successful business men.

THE NOWOTNY IMPERIAL BATTERY.

In developing the Imperial battery, it has been the aim of the manufacturers to produce a battery that is superior to anything heretofore put upon the market, regardless of cost.

The Imperial is an improved form of the multiple. Its combined strength, durability, recuperative qualities and long life with an enormous working power are even beyond the expectations of the makers.

In this battery there is by actual measurement 196¼ square inches of available carbon surface below the fluid line exposed to chemical action. This surface is placed in such a manner that the internal resistance of the cell is cut down to the lowest possible point.

Nowotny Imperial Battery.

The entire outer cell is made of carbon, taking the place of the glass jar, and serving the double purpose of a negative-exciting element and a retaining vessel.

There are eight inwardly projecting ribs of carbon extending over the inner surface of the cell pointing towards the centre, and surrounding the zincs on all sides. The inside of the cell is also corrugated for the purpose of increasing the surface.

This Imperial battery is manufactured by the Nowotny Electric Co., 30 E. 5th street, Cincinnati, O.

THE BALL & WOOD CO.

The Ball & Wood Company were represented at the National Street Railway Convention at Pittsburgh, by Mr. F. H. Hayward, formerly connected with the Straight Line Engine Co., of Syracuse.

A. M. Morse & Co., mechanical and contracting engineers, have located at St. Louis, Mo., as the selling agents for the company. Mr. Morse is an experienced engineer, and a very successful salesman, formerly of the firm of English, Morse & Co., of Kansas City.

The firm of Mead & Stringham has been formed with offices in the Hammond Building, Detroit, Mich., where they will conduct a general engineering and contracting business, and will act as special agents for the Ball & Wood Company. Both members of the firm are mechanical engineers with wide experience in steam construction, and well known to the trade throughout Michigan.

The Ball & Wood Company have found it necessary to run the Elizabethport shops all night that they may keep up with orders, that have been coming in very rapidly.

THE ELECTRICAL ENGINEERING AND SUPPLY CO.

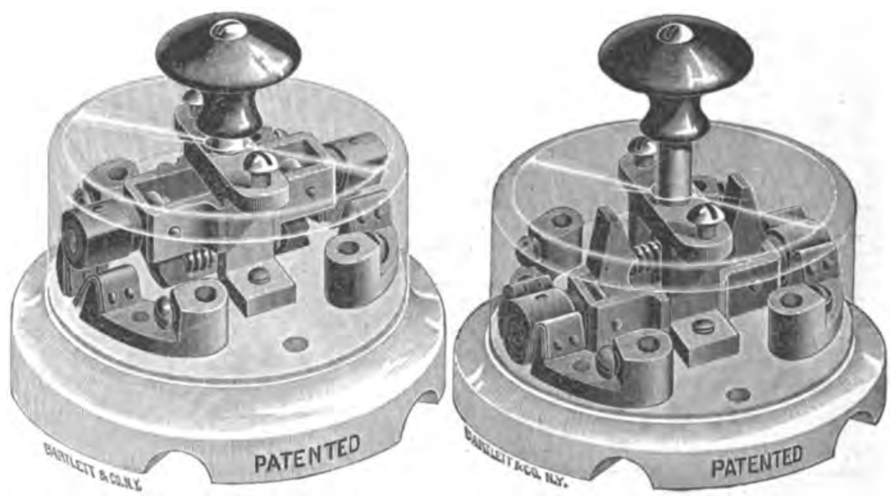
The above company, of 134 East Sixth street, St. Paul, Minn., have found, in moving into their new quarters, that business is again growing upon them. They have now been going just a year, and their supply trade has proved most encouraging right along. Mr. Morgan Brooks, the treasurer, writes us: "We have recently completed the installation of an incandescent plant at Audubon, Ia., and having received check in full for same last week, it makes us feel as if our efforts were successful. That was a plant of the National system. With the enormous crops harvested this fall, we feel that business will continue to boom for many months to come. Our greatest difficulty at present is that we cannot get supplies shipped to us promptly enough to fill orders."

THE PERRET ELECTRIC MOTOR.

The Elektron Manufacturing Co., of Springfield, Mass., have issued a very well printed and illustrated pamphlet, descriptive of the Perret motors manufactured and sold by them. The body of the work is taken up by a detailed description of the motors and their advantages, while the last two pages are devoted to testimonials of a flattering character recently received by the company. The New York office of the Elektron Manufacturing Co. is at 89 Liberty street.

A NEW "UNION" SWITCH.

The accompanying illustrations, Figs. 1 and 2, show the new switch designed and brought out by the Union Electric Mfg. Co.,



Figs. 1 and 2.—New "Union" Switch.

of Bridgeport, Conn. As will be seen, the switch is shown open in Fig. 1 and closed in Fig. 2. The mechanism is so plainly shown that nothing remains to be said in regard to the switch, except that no expense has been spared to make it perfect in every respect.

UNDERWOOD COTTON LEATHER BELTS.

The Underwood Manufacturing Co., sole makers of the well-known cotton leather belting, have shipped to Pittsburgh, for exhibition at the Street Railway Convention, a big cotton leather belt which is to go to the Chicago City Railway Co. as one of two belts for that company. The length is 200 feet, width 62 inches, and the belt speed is to be over a mile a minute. The same company have in use two 48-inch Underwood C. L. belts, each 172 feet in length, which have been in use over four years. The belts are run about twenty-two hours per day.

The Engineering Equipment Company, of 143 Liberty street, New York, selling agents of the Underwood Manufacturing Co., arranged to exhibit this big belt at Pittsburgh, and Mr. Crane, who represents their railway department, was in attendance at the convention.

Mr. F. P. Mack represents the Underwood belting interests in Chicago, at 65 South Canal street.

Mosher Arc Lamp Co.—The above company, of 125 Ontario street, Chicago, J. M. Fisher, manager, write us that orders for lamps are exceeding their most sanguine expectations. It is all they can do to supply the demand. Customers are delighted with the appearance of the lamp and the steadiness of the light, as well as with the simplicity of the system.

SOUTHERN ELECTRIC CO.

MR. J. F. MORRISON, the president of the Southern Electric Co., Hoen Building, Baltimore, Md., has issued the following important notice: "Having associated with me several well-known business men, we have incorporated under the laws of Maryland the Southern Electric Company, and will carry on the electric supply and construction business, heretofore conducted as an individual enterprise. This incorporation broadens our field of operation and affords us much greater facilities for handling with dispatch all business entrusted to us. We are in position to give estimates, at reasonable notice, on all work pertaining to our lines, and with a full corps of experienced workmen, are prepared to fill contracts and execute orders promptly. By faithful attention to business, with good and honest service to our patrons, I hope to merit, if possible, a higher degree of confidence for our company than has been so kindly extended to me personally."

Associated with Mr. Morrison as directors of the company are Aubrey Pearre, of Pearre Bros. & Co.; F. W. Schultz, of the Schultz Gas Fixture and Art Metal Co.; John Waters, builder, and J. S. Boyd, who is secretary and treasurer.

C. & C. ELECTRIC MOTOR CO.

THE C. & C. Electric Motor Company, New York, are very busy. They have recently installed a 75 light dynamo for the Show Steam Pump Co., Buffalo, N. Y.; one 175 light for the Cogdon Brake Shoe Co., 59th street, Chicago, Ill.; one 500 light in the Mitchell Flats, Cincinnati, O.; two 250 light in the St. Nicholas Hotel, Cincinnati, O.; one 125 light for Mock, Berman & Co., 119 West 3d street, Cincinnati, O.; one 150 light for W. J. Morgan & Co., Cleveland, O.; one 100 light for the Bethel Association, Cleveland, O.; one 60 light for the Northern Ohio Asylum for the Insane, Cleveland, O.; one 100 light for the Steamer "Royal," Evansville, Ind.; one 40 light for the Upton Glue Co., Gardiner, Me.; one 40 light for the Boston Paper Co., Hallowell, Mass.; one 200 light for the iron foundry of T. Shriver & Co., 333 East 56th street, New York.; one 150 light for Messrs Weser Bros., piano manufacturers, 524 West 23d street, New York; one 40 light for the Upton Glue Co., Peabody, Mass.; one 150 light for Jordan & Goodrich Shoe Co., Ravenna, O.; one 500 light for lighting the offices of the Brush Electric Light Co., Rochester, N. Y.; one 40 light for the Upton Felting Mills, Salem, Mass.

ELECTRICAL WORK AT POTTSVILLE, PA.

THE new court-house of Schuylkill Co., situated at Pottsville, Pa., was opened on the 3d inst. The building is of a very handsome design, built of Ohio sandstone, and wired throughout for electric lighting. The building is divided into four circuits, supplying current for 500 20 c. p. lamps. No expense has been spared, and the whole work has been installed in a very thorough and careful manner. The wire in use is manufactured by the well-known Safety Insulated Co., of 234 W. 29th street, New York, and in order to ensure more perfect insulation each wire is enclosed in "interior conduits," about 6,500 feet of which have been used. When all lamps were burning the whole installation showed only a drop in potential of 2 per cent., a result which shows the general excellence of the work. The fixtures were furnished by the Mitchell-Vance Co., and the large ones in the court-rooms, having from 20 to 24 lights, deserve special mention, being of exquisite workmanship and beauty in design.

The installation was under the supervision of Mr. G. H. Barker, general manager of the Edison Electric Illuminating Co., of Pottsville, who received many flattering congratulations from the court officials.

The Electric Co. have at present nearly 3,500 lamps in use, and a number of new orders in hand.

F. P. LITTTLE & CO.

THE above active concern, of 141 East Seneca street, Buffalo, N. Y., have just closed a contract with the Broezel House, of that city, which calls for wiring for 800 lights, including two arcs. The plant will consist of two Thomson-Houston dynamos of 300 and 500 lights respectively, driven by a 30 h. p. and a 50 h. p. Rice automatic engine. The contract includes the construction of the plant complete.

THE STEWARD LAVA INSULATORS.

THE D. M. Steward Manufacturing Co. of Chattanooga, Tenn., write us: "August was a good month in lava insulators, but September is a long way ahead of it. It seems that when electricians get an unusually trying place for an insulator, and everything else fails, they fall back on the old reliable "Lava."

POND ENGINEERING CO.

THE Waterloo, Ill., Electric Light & Power Company are making good progress with the installation of their plant, and expect to be ready for operation by November 1. The work is in the hands of the Interstate Complete Electric Construction Company, of St. Louis, and the steam plant will be furnished and erected by the Pond Engineering Company of the same city. The latter contract covers Armington & Sims engine, steel boiler, Lowe heater, Blake boiler feed pump, and Universal injector. The Heisler system of long-distance incandescent lighting is to be used, and the plant is to be a model one in every respect.

ANOTHER GOLD MEDAL FOR OTTO GAS ENGINES.

THE German correspondents of Schleicher, Schumm & Co., Philadelphia, inform them that at the Strasburg Industrial Exposition, where an unusually large number of gas engines of all makes and description were exhibited, they alone were awarded for their "Otto Gas, Gasoline and Petroleum Engines" the highest diploma and gold medal for superior design and workmanship. Second prizes were given to Adam, Benz, Buss-Sombart & Co., Hille, the Kobers Iron Works, Escher-Wyss & Co. Third prizes to Grob & Co. (Capitaine Petroleum Motor), Korting and Bitschweiller (Petroleum Motor).

THE IMPERIAL SOCKET.

THE accompanying illustration shows a new socket manufactured by the Imperial Electric Company, of 1218 and 1220 Filbert

THE IMPERIAL SOCKET.

street, Philadelphia. The insulation of the socket is made entirely of porcelain, and is, therefore, unaffected by heat or moisture. The principal feature claimed for this socket is, however, that, by reason of its construction, it is very easily wired, and is, therefore, especially adapted to chandelier and fixture work. The design is simple and neat, and the appearance symmetrical and sightly.

ORDERS FOR SCHIEREN BELTS.

CHAS. A. SCHIEREN & Co., of 47 Ferry street, this city, have received an order from the Diamond Electric Co., Seventeenth and Clearfield streets, Philadelphia, for two 30-inch double belts; one 16-inch double; one 15, two 12, and four 11, for their new power plant. This is the entire belt equipment. The firm report a steady increase in the demand for their patent "Perforated" belting, especially for electric railway work, where it is desirable, because, it is said, it can be run slacker than an unperforated belt; without slipping. No charge is made for the perforations; they are given gratis.

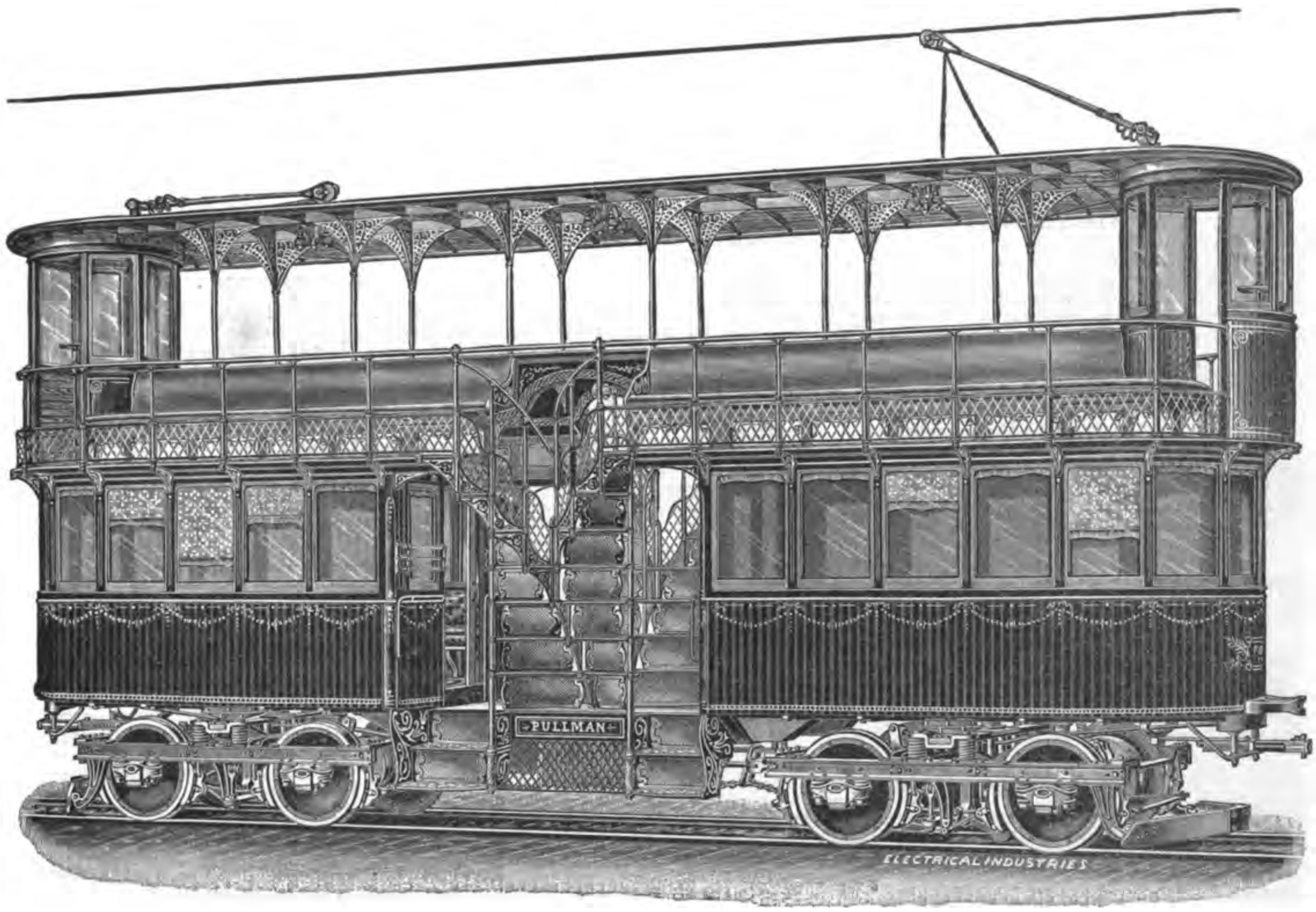
THE MERRIMACK ROAD, LAWRENCE, MASS.

THE local *Telegram* says: "The advent of electric cars in Lawrence is followed by greater prosperity to the Merrimack Railway Co. than ever before known." The road is equipped with eleven motor cars, and four more are at once to go into service. On a recent Tuesday and Wednesday 35,000 people paid fares. The motors of the Detroit Electrical Works are used. Mr. J. E. Lockwood was in charge of fitting up the cars, assisted by Messrs E. P. Ashton and L. H. Temme.

THE PULLMAN CENTRE-VESTIBULE DOUBLE-DECK ELECTRIC CAR.

THE accompanying illustration shows the new double-deck electric car recently built by the Pullman Palace Car Co., and described in our columns last week.

The car is sheathed outside with narrow strips, the same as the ordinary passenger coach; the inside finish is mahogany, with decorated quartered-oak ceiling. The glass in the windows is crystal sheet, while that in the doors is French plate, embossed. Mirrors are placed on the upper deck and on each side of the doors, and the car is provided with spring seats and backs, covered with tapestry. The car is provided with two gates, each gate equipped with a seat. The wheels are Allen 30 inch, with steel tires. The motive power is furnished by two Westinghouse single-reduction motors of 25 h. p. each, one motor on each truck. The whole electrical equipment is due to the judgment of Mr. C. L. Pullman, the contracting agent of the Pullman Company.



PULLMAN CENTRE-VESTIBULE DOUBLE-DECK ELECTRIC CAR.

It is interesting to add that the West End Electric Railway Co., of Boston, have already ordered four of these cars.

FITCHBURG STEAM ENGINE CO.

THE Fitchburg Steam Engine Co., Fitchburg, Mass., report business as being exceedingly good just now, and that they have a large amount of work on hand, but expect to remove their plant to their new works very soon. They are just shipping a 600 h. p. cross-compound condensing engine to the Powelton Electric Light Co., Philadelphia, this being the third engine of the sort they have shipped them; also two 60 h. p. engines to the Norman Paper Co., Holyoke; and expect to soon ship two large engines for the W. C. T. U. Temple, in Chicago, Ill.

They have recently received the following orders: Two large engines for the American Sugar Refining Co., to go in at the Havemeyer Co.'s works, in Brooklyn; 175 h. p. engine, Sayre & Fisher, Sayreville, N. J.; 150 h. p. engine, including boilers, etc., for Geo. W. Sharer, Little Washington, N. J.; two large tandem compound high-speed engines for L. W. MacCormack, Chicago, Ill.; 125 h. p. engine for the Revere Rubber Co., Boston; 75 h. p. engine for Keasbey & Mattison, Ambler, Pa., this being the fourth engine they have shipped them; 50 h. p. engines for the Meriden Curtain Fixture Co., Meriden, Conn.: Wilcox, Crittenden & Co., Middletown, Conn.; L. Sartelle & Son, Pepperell, Mass.; also, orders for smaller engines for the Rockland Building Association, Rockland, Me.: J. D. Bergen & Co., Meriden, Conn.; C. T. Sampson Mfg. Co., North Adams, Mass.; John Bower, Philadelphia; Hollingsworth & Whitney, Boston, and the Northampton Emery Wheel Co., Leeds, Mass. They have also recently started large compound engines for Gallup & Houghton, North Adams, Mass., besides many large engines in Philadelphia and the immediate vicinity.

"A PAINT WHICH COMBINES THE MOST GOOD QUALITIES."

THE Roessler & Hasslacher Chemical Company, 73 Pine street, New York, are prepared to prove that their protecting and insulating "Isolatine Paint" combines more good qualities than any other paint now in the market, and to judge from the array of evidence which they produce, managers, superintendents and contractors will find it to their interest to investigate these claims. This evidence will be published shortly.

It is not supposed, of course, that the statements of the manufacturers will be taken without additional trials, as naturally new combinations of circumstances create a vast number of variations, so that the material must show its capacity for each individual case before being accepted.

However, the tests made by the above firm with "Isolatine Paint" may be taken as proving conclusively what they assert, and just that much labor is saved.

A paint which remains always pliable will prove valuable in many a place. If to that is added permanent adhering and waterproof qualities, it at once embraces practically the entire protective and anti-rust field. And supplement this with good penetration for both metal and wood; a fine glossy, black, finish; the highest resistance to electrical currents, as well as to solutions of acids, alkalies and salts, and you have "Isolatine Paint."

DETROIT ELECTRICAL WORKS.

THE above progressive and energetic concern have issued for distribution at Pittsburgh a very interesting and pithy pamphlet which discusses the various questions connected with electric railway work and touches on each so as to bring out the distinctive merits of their system. Great emphasis is skillfully laid upon the various good features of the single motor, with its one armature, one set of field coils, one commutator, one set of armature bearings, and one set of brushes; yet driving upon both axles, so as to obtain the full measure of possible tractive effect.

THE WILLIAMS RADIAL TRUCK.

THE Williams radial truck designed by Mr. H. B. Williams, of 157 State street, Rochester, N.Y., consists of a pair of wheels placed under a bolster and fifth wheel and attached thereto with spiral springs. A king-bolt fastens the body of the car to the bolster. Attached to the axle by a journal are two arms that act as supports for an axle on which are a pair of pilot wheels. These arms also extend backward and support a similar pair of pilot wheels. The arms extend 24 inches either way, so that when the car is started in an opposite direction the back pair is forced down to the track, and in turn become pilots or guides. The reversing is done by hand at the beginning of a trip, and the pilots are held down to their place by a bolt slipping through a hole in a hanger attached to the bolster. The pilot wheels are mounted on ball bearings and run without noise. Their duty is to feel curves before the big wheels reach them, and by their leverage swing or turn the bolster radially with the track and prevent the flanges of the carrying wheels from grinding, or much more than touching, the rails. An arm reaching forward and backward from the bolster, and attached to the centre of the pilot axle, is really the lever by which the bolster is turned. Each pair of carrying wheels is similarly mounted, and acts entirely independently of the other, so that while the forward pair of wheels may be turning, the back pair may be running straight until they reach the curve or switch.

The bolster turns on a fifth wheel, and attached to it are a pair of small roller wheels which travel on the fifth wheel, and allow the bolster to be very easily turned. Leading backward and forward on the fifth wheel is an incline of a few inches, at the bottom of which the roller wheels rest while the car is running straight, effectually locking the truck by the weight of the car. Whatever the length of the car, the carrying wheels are only placed 24 inches from the extreme end. Thus a 24-foot car would have a wheel base of 20 feet. This great base does away with the annoying vertical motion.

The car will turn in a 10½-foot radius with but little more draft than on a straight track, owing to the absence of grind on the rail by the load-carrying wheels. A 24-foot car can be easily turned in less than its length. A balloon at the end of the track can be made very small, in fact, in a narrow street, so that a car can be turned without shifting the trolley. Owing to the trucks becoming radial, the ends of the car remain nearly over the centre of the line of curvature. There is plenty of room to hang a motor under the bolsters, and the economy of power in curving is another important feature.

H. WARD LEONARD & CO.

H. WARD LEONARD & COMPANY now have on exhibition at their offices, in the Electrical Exchange Building, 136 Liberty street, a Crocker-Wheeler motor operating under Mr. Leonard's new principle for controlling the speed, torque and direction of motors. The motor is made to perform various work in such a manner as to show clearly the principle used and the facility with which either the speed or torque is controlled. The exhibition is extremely interesting.

The first elevator to be operated upon the new principle invented by Mr. H. Ward Leonard was tested on Thursday, the 6th inst., and the result was an unqualified success in every particular. The elevator is that in the Central Station of the Edison Electric Illuminating Co., of Brooklyn. The operation of the elevator is controlled entirely by the movement of a handle in the elevator car, and the operation of the elevator is under the most perfect control. The smoothness of the motion of the elevator, both in increasing and decreasing the speed and in reversing the direction of motion, is extremely surprising to those who have been used to the peculiar sinking sensation experienced in the modern high-speed elevator. Supt. Barstow is much pleased with it.

The company report that their subscriptions for "Electrical Intelligence" are coming in in an extremely satisfactory manner. Owners of central stations and isolated plants seem to quickly appreciate the great advantages to be derived by securing information from a concern such as this at such moderate rates. Quite a large number of supply houses and even electrical manufacturing companies are among the subscribers. For special information, such as is called for by concerns of the latter description, special rates are quoted.

"THE TRAMWAY AND RAILWAY WORLD."

UNDER the above appropriately selected title, a new monthly illustrated review, devoted to the interest of steam, electric, cable and other traction, is to be published in London, England, at an early date. Its special province will be to promote European and also American traction interests abroad, and it will afford a valuable medium for advertisers on both sides of the water. As is well known, improved methods of street railway traction have received enormously wider practical adoption in this country than in any other part of the world, and to advocate and promote the use of these modern means as employed here will be a special feature of the new journal.

The present time appears especially opportune for the establishment of such a paper, in view of the fact that several concessions have recently been granted for the construction of electrically equipped lines by means of the overhead trolley system in various parts of Europe. Further, it is an interesting fact that all the Continental Europe, South American and Indian tramway and railway companies are owned and have their offices in London, and there being no similar publication, the paper will fill a field peculiarly its own.

Prominent and influential men associated in traction industries abroad recognizing the need of such a journal, have already accorded to the promoters their official support, and its prospects are of the most encouraging nature.

Mr. Frank X. Cicott, of Chicago, will leave shortly for London, to assist in launching the new venture, and on his return will represent its interests in this country. The staff will comprise editorial and business talent, both English and American, and the gentlemen composing it have had wide experience in the several branches of tramway and railway interests.

A LARGE SHIPMENT TO BRAZIL.

THE Berlin Iron Bridge Co., of East Berlin, Conn., have just sent 23 carloads of iron building material at one shipment by a special train over the N. Y., N. H. & H. R. R. for the Companhia Nacional de Fojas e Estaleiros, Rio de Janeiro, Brazil, S. A. This is one of the largest single shipments that ever passed through New England, the combined weight of the 23 cars being nearly 1,000,000 pounds. The shipment goes to the Harlem River station, New York, and is there lightered aboard a Brazilian steamer and shipped direct to Rio de Janeiro.

This building is for a car works for the Companhia Nacional de Fojas e Estaleiros. Not only the building is to be furnished in this country, but also all the tools and machinery for the entire equipment.

THE "IDEAL" ENGINE.

THE hotel "Marlborough" Co., cor. 36th St. and Broadway, are about to install a 100 h. p. "Ideal" engine. This makes the third of these celebrated self-oiling automatic engines that they have ordered. These engines are built by the Harrisburg Foundry and Machine Works, Harrisburg, Pa., whose factory is busy with the many orders they have received. They have recently made large improvements in their equipment in the way of new machinery, which enables them to fill their orders promptly. A great many of the orders they now have are from the New York representatives, W. R. Fleming & Co., 174 Fulton street.

BALL ENGINE CO.

THE Ball Engine Co., Erie, Pa., has shipped the World's Fair one 60 h. p. engine for operating the incandescent electric light plant on the grounds.

The Wesleyan University, Middletown, Conn., are installing a 25 h. p., built for them by the Ball Engine Co., Erie, Pa.

The Johnson Co., Johnstown, Pa., have recently ordered from the Ball Engine Co., Erie, Pa., a 60 h. p. engine, being the twenty-second engine built by them for the Johnson Company, aggregating over 3,000 h. p.

MR. J. STANFORD BROWN.

THE above-named electrical engineer is now well established at 611–612 Electrical Exchange, Liberty street, this city, and is actively engaged in consulting and constructing, his assistance being sought in connection with a great variety of important work. Mr. Brown has had special experience in motor construction and electric railway work, and his services are found of value in that still new department of applied electricity.

THE TORONTO CONSTRUCTION AND ELECTRICAL SUPPLY CO., Toronto, Can., have been appointed agents for the Dominion for the New York Insulated Wire Co., to handle Grimshaw "White Core," B. D. wires, tapes and compounds, and the "Vulca" ducts and interior wiring appliances.

CHICAGO INSULATED WIRE CO.

THE town of Sycamore, Ill., has secured the Chicago Insulated Wire Co., which is expected to give employment to 125 hands. Sycamore gives the company a bonus of $12,000 and four acres of valuable land adjacent to two railroads.

AMERICAN ENGINEERING CO.

THE American Engineering Co., of Jersey City, N. J., has been formed with a capital stock of $1,000,000 to construct steam and electric power plants, manufacture machinery, etc.

NEW YORK NOTES.

THE "C. & C." ELECTRIC MOTOR CO., New York, are installing a 100 lt. dynamo for Mrs. Mary Jacobshagen, Union Sugar Plantation, La.; one 100 lt. for John T. Moore, Shriver, La.; two 600 lt. and one 300 lt. in the Erie County Savings Bank Building, Buffalo, N. Y.; one 200 lt. for John D. Muller, corner 5th avenue and Union street, Brooklyn, N. Y.; one 100 lt. for the Crescent Farm Planting Association, La.; one 125 lt. for Shaffer Bros., Ardoyne Sugar Plantation, La.; one 125 lt. for Messrs. Walbridge & Co., Buffalo, New York, and one 100 lt. for the Magnolia Plantation, La.

THE CROCKER-WHEELER MOTOR COMPANY, of New York, has placed Mr. D. Herbert Jeffery, of Jersey City, N. J., in charge of its offices, handling its large correspondence, management of records, etc. This step has been found necessary to relieve the other officers of the company of these duties in order to enable them to meet the exacting requirements of their several branches of the business, electrical, technical, installation, etc., each of which receives the personal attention of an officer.

THE ENGINEERING EQUIPMENT COMPANY have leased for a term of years the handsome store premises next the main entrance in the Central Building, 143 Liberty street, where they are now located on the second floor. By this move they secure stock room for Underwood cotton leather and other belting specialties, etc., which have been kept at 73 Cortlandt street. The Boston offices and salesrooms of the company are at 126 Pearl street, where Mr. F. A. Magee, who is in charge, is kept busy on Eastern trade.

MESSRS. DICK & CHURCH, whose New York office is at 16 Dey street, are selling a great many of their automatic cut-off engines. These engines are built at the Phœnix Iron Works, Meadville, Pa., and are made simple, tandem compound, cross-compound, and triple-expansion. They also manufacture boilers, heaters, etc., and furnish estimates on electric light and railway power plants. One of their latest engines was described in THE ELECTRICAL ENGINEER of September 30th.

MESSRS. J. JONES & SON, of 602 and 604 W. 22d St., have a very complete assortment of electrical apparatus and supplies, including lamps, push-buttons, annunciators, bells, batteries, and electric gas lighters. The Berlin watch demagnetizer, one of their specialties, was described in THE ELECTRICAL ENGINEER of March 18th.

THE NEW YORK AND OHIO CO., recognizing the demand for a one ampere 50 volt lamp for use in central stations where the cost of power is excessive, are now ready to supply them. This lamp absorbs about 3 watts per candle, and notwithstanding the high efficiency has a long life, and like all the other Packard lamps, is entirely free from discoloration.

MR. J. HOLMES, of 74 Cortlandt street, has commenced a business in second-hand electrical materials, including arc and incandescent dynamos, motors, lamps, and general supplies. He also deals in engines, boilers, pumps, etc., and complete steam plants.

PHILADELPHIA NOTES.

MR. L. ATWOOD a mechanical expert, was called to Richmond, Va., last week, by the city engineer to confer with him and the committee on streets for the purpose of considering the methods of relief from the unnecessary noise made by the motors on both the Union and City Passenger Railway Co's. roads. After a consultation they have decided to try the Atwood patent motor gear, which has been in use on the Richmond & Manchester Railway for the past year, giving perfect satisfaction to the citizens and owners of the road. These gears are being manufactured in large quantities by Mr. Atwood at Bridgeport, Conn. It is said that by the use of his gears the noise is eliminated, while the gears require no lubrication and are stronger than steel or iron. Chilled pinions can be used with these gears, which reduces the cost of pinions to about $2.

THE ARNOLD ELECTRIC CO., of Chester, Pa., has just installed a 500 light plant at the Thackara Mfg. Co.'s store and factory.

THE LAROCHE ELECTRIC WORKS are compelled to run a portion of their works night and day owing to the large demand for their improved dynamos. They report the following recent installations: Col. Henry A. du Pont, Wilmington, Del., 150 arc; J. E. Frick & Co., Langhorne, Pa., 75 incandescent; American Hosiery Mills, Royersford, Pa., 75 incandescent; A. P. Hill, Darby Road, Pa., 100 incandescent; T. J. Oliver, 19th and Reade streets, 35 incandescent; Gerson's Millinery, 8th street, 15 arc; Quaker City Watch Case Co., 6th and Chestnut streets, 5 h. p. motor; J. P. Weimer, 705 Sansom street, 2 h. p. motor; J. P. Mathews & Co., Phila., 100 light dynamo; Wm. J. Callaghan, 22 North 5th street, 2 h. p. motor; Oliver R. Reed, 1323 Arch street, two ½ h. p. motors; Geo. H. Earle, Devon, Pa., 1 h. p. motor.

DR. W. A. DRYSDALE, the consulting electrical engineer, has removed his office from 1531 Arch street and now occupies handsomely furnished offices in the Hale Building, Juniper and Chestnut streets. Dr. Drysdale has just completed the installation of the work at the Empire Theatre and is now busy with the plants at Messrs. Bailey, Banks & Biddle, the Philadelphia jewelers; Messrs. Boothby & Kugler's restaurant; a large storage battery plant for Wm. Simpson's Sons & Co.; the New Century Club, and a number of other smaller equipments.

MESSRS. THOS. H. DALLETT & CO., of Philadelphia, intend making a specialty of the Billberg generator, which they manufacture, coupled direct to the Triumph valveless compound engine on one base. This will do away with friction clutches and details of a similar nature. This company is the sole Eastern agent for the above engine. Mr. Newton L. Schloss, the manager of the New York office, has had wide experience in this direction with the Edison General Electric Company, and is especially fitted for this class of work.

MESSRS. WRIGHT & STARR, electrical engineers, have removed their office from 37 South 3d street to Room 501 Girard Building. Their car "Direct," which has been equipped with the Waddell-Entz system of storage batteries, has been out on the road several times recently, and is expected to be in service this week on the 2d street road at Chester. The Union Car Co., as well as Messrs. Wright & Starr, are very much satisfied with the working of the battery up to date.

MR. J. COOPER CLOUD, representing the Thomson-Houston Electric Light Co., has secured the contract from the Bala & Merion Electric Co. to install their entire plant consisting of two 650 light alternating dynamos; two 65 h. p. Westinghouse compound engines and two 70 h. p. horizontal tubular boilers, made by the Coatesville Boiler Works. The competition for this plant was exceedingly sharp by parties representing the standard makes of machines, and much credit is due Mr. Cloud for capturing this plum.

THE MILLVILLE, (N. J.) ELECTRIC LIGHT & POWER CO. has contracted with the Fort Wayne Electric Co., through their Philadelphia agent, Mr. G. A. Wilbur, for three 50 Wood arc light dynamos. Messrs. Clay, Pepper & Register have been awarded the contract for the construction work, which will necessitate the use of over fifteen miles of "Simplex" wire.

MR. H. T. PAISTE is moving his factory and office from 12th and Market streets to the Fuller Building at 10 South 18th street, where he will occupy the entire third floor. New machinery will be put in, which, with the commodious quarters, will enable Mr. Paiste to keep pace with the increasing demand which he is receiving for his electrical specialties.

NEW ENGLAND NOTES.

THE WHITNEY ELECTRICAL INSTRUMENT COMPANY, formerly of Manchester, N. H., have decided to build a three-story factory 100 feet long and 50 feet wide at Penacook, N. H. The site secured is an admirable one, with ample room for enlargement, and with a large and powerful water power. Two 54 inch wheels will be put in at present, and power leased to neighboring shops. The Whitney Company will manufacture instruments, the inventions of E. R. Whitney and Dr. A. H. Hoyt, and the stock of the company is chiefly held by members of the Gould and Watson Company, of 35 Hartford street, Boston, where the management of the company have their office at present.

THE BERLIN IRON BRIDGE CO., of East Berlin, Conn., have received the contract for the new blacksmith-shop building for the Dixon Mfg. Co., of Scranton, Pa. Owing to the peculiar formation of the ground the building will be in the form of a letter L, and will be 60 feet wide by 235 feet long, constructed entirely of iron.

MR. ALBERT SCHEIBLE, representing Mr. George Cutter, of Chicago, was in Boston a few days last week getting acquainted with his numerous customers and patrons. Mr. Scheible is well known as having been largely instrumental in the designing of Mr. Cutter's many clever advertisements.

THE TESTING DEPARTMENT of the Massachusetts Electrical Engineering Company, of Boston, has just issued a pamphlet calling attention to certain points concerning the use and reliability of fuse wire. They show the necessity, not only of using a properly tested wire, but also for the exercise of care and judgment in the selection of the size to be used when the surrounding conditions are unlike those of testing. For example, a wire which fuses at 50 amperes in a fuse-link five inches long would require over 100 amperes if the link had but one inch of wire. This company have designed especially for each system of cut-outs, fuse-links made of their tested fuse wire attached to copper terminals.

THE WAINWRIGHT MANUFACTURING COMPANY of Boston, have recently sold the following heaters: Frackville and Gilberton Electric Light, Heat and Power Company, of Frackville, Pa., 100 h. p.; the Wilmington City Railway Company, Wilmington, Del., 300 h. p.; Liberty Electric Light Co., Liberty, Miss., 50 h. p.; Suburban Electric Light Company, Philadelphia (third order) 200 h. p.; Sternes, Roger & Company, Denver, Col., one 200 and one 300 h. p.; A. M. Holter Hardware Company, Helena, Mont., 150 h. p.; and Russell & Company, Massillon, O., 400 h. p.

CLAFLIN & KIMBALL, of Boston, report the fact that the special railway lamp which they have introduced during the past season has met with a very large sale and has been very successful in practical use. The lamp is specially constructed to stand the variations in potential, and the severe jarring consequent from service on electric cars. The lamps are so made that they can be placed in any position; will resist vibrations and stand shocks better, they claim, than any other lamp hitherto constructed for that purpose.

MR. ALBERT H. MILLS, of the Steele and Johnson Manufacturing Company, of Waterbury, was in Boston last week looking up his numerous friends, and reports business as being extremely brisk in the Naugatuck Valley. The Steele and Johnson Company have made quite a reputation for themselves on their well-known shade-holder, and have obtained a large business in the general manufacture of light brass goods for general electrical purposes.

THE SAMSON CORDAGE WORKS, of Boston, note a largely increased demand this fall for their solid braided trolley cord, the most common orders being for white cotton No. 8, waterproof. The linen cord is somewhat stronger, but the manufacturers consider that cotton is more economical and amply strong for the purpose. Samples, catalogue and discounts are gladly sent on application.

ALBERT & J. M. ANDERSON have, up to the present, equipped every car on the West End Street Railway, of Boston, with their patent tapered steel trolley pole, with the exception of a very few still using the old wooden pole. Their trolley base is also in large demand, and they have recently received several orders from Europe.

THE NEW HAVEN INSULATED WIRE COMPANY, of New Haven, Conn., in order to meet the increasing demand for their insulated wires, have opened an office at room 308, 18 Cortlandt street, New York, in charge of Mr. H. G. Madden, as sales agent.

MR. C. E. BIBBER, of the Consolidated Electric Manufacturing Company, of Boston, is at present in the West, and will return by way of Pittsburgh.

WESTERN NOTES.

THE WRITING TELEGRAPH.—A highly successful trial of the writing telegraph was made Sunday, Oct. 4th, between St. Paul and Chicago. The instruments of the Writing Telegraph Co. have now been so perfected that the sending between very long distances is eminently satisfactory and reliable. Mr. W. E. Gump, the general manager of the company took the St. Paul end of the line, andMr. H. Etheridge, the Chicago one at the office of the North American Telegraph Co. The writing was exceptionally good, maintaining exactly the characteristics of the handwriting of the sender.

THE ELECTRICAL SUPPLY COMPANY, of Chicago, report an increasing demand for their Ajax dry battery. A recent shipment of 1,200 to one Western firm would confirm the idea that dry batteries are a fixture.

MR. F. H. LEONARD, JR., vice-president of the Electric Engineering and Supply Co., of Syracuse, New York, was a recent welcome visitor to Chicago. Mr. Leonard is making an extended Western trip in the interest of his company, and reports business as excellent.

GEORGE CUTTER has received another large shipment of "Cutter's Elastic Tape," which he is selling steadily in connection with Simplex rubber wire. It is made from a pure rubber stock and is said to give a fine joint even when no heat is applied to it.

THE ELECTRIC MERCHANDISE CO. report for the last week sales of Burton electric heaters to the following roads: Spokane Electric Railway, Spokane, Wash.; Danville Electric Railway, Danville, Ill.; Stillwater Electric Railway, Stillwater, Minn.; Terre Haute Street Railway Company, Terre Haute, Ind.: Burlington Electric Railway, Burlington, Iowa; Reading and Southwestern Railway, Reading, Pa.; Eau Claire Street Railway, Eau Claire, Wis.: People's Street Railway, Springfield, Ill.; Salt Lake Rapid Transit Company, Salt Lake City, Utah; Electrical Supply and Construction Company, Pittsburgh, Pa; Minneapolis Street Railway Company, Minneapolis, Minn.; Pullman Palace Car Company, Pullman, Ill.; Windsor and Sandwich Railway, Windsor, Canada.
Electric heating by the Burton Company's process is a fully demonstrated success, and the great advantages of this method of heating are realized by managers of electric roads.

MR. WILLIAM HOOD, 239 La Salle street, Chicago, is still filling orders for the favorite "Jewel" incandescent lamps, which are now to be found in use in a large number of central stations and isolated plants, where they are giving excellent satisfaction and proving to fill the requirement for a reliable, long-lived lamp, using small current and maintaing full candle-power. Mr. Hood will also place on the market shortly a new dry battery having exceptional properties and remarkable constancy, and which he is preparing to manufacture on a large scale. These dry batteries have received exhaustive tests. One small cell will ring an ordinary bell for seventy-eight days of twenty-four hours each absolutely continuously.

MR. C. M. BARCLAY and Mr. W. Sharpe, both gentlemen well known in the electrical business, have opened an office at No. 549 "The Rookery," Chicago, under the firm name of Barclay & Sharpe. They have secured the agency of the Woodbury automatic engine, and the water tube and steam boilers manufactured by the Stearns Manufacturing Co., of Erie, Pa., and also of the Padway heater. Both gentlemen are wide-awake business men, with a large acquaintance, and will undoubtedly do a prosperous business.

PROF. ELISHA GRAY, of Highland Park, laid some Okonite wire under ground ,without any protection whatever, over three years ago, on which his telautographic experiments have since been conducted. The wire is still in perfect condition, showing an infinite insulation resistance. The Central Electric Company report that they never have any comments on this superior grade of insulation, except such as are favorable, and of which the above is a sample.

OKONITE TUBING seems to be fast replacing the soft-rubber tubing for special insulating purposes. This is composed of a tough and almost indestructible compound and has all the high insulating qualities that the Okonite wires possess. It has a decided advantage over the ordinary soft-rubber tubing in that it is not in any way affected by exposure or by the action of the elements.

MR. H. M. UNDERWOOD, widely known in electrical circles and until recently general agent of the Interior Conduit & Insulation Co., of New York, has associated himself with the Knapp Electrical Works, of Chicago, as general salesman. Mr. Underwood will devote special attention to pushing "Safety" wire.

MR. L. W. COLLINS, who for some time has represented *The Electrical Review* of New York in the West, has resigned his position and accepted one as general representative of *Electricity*. Mr. Collins is a pushing, wide-awake advertising agent, and well known and popular among the electrical fraternity.

THE CENTRAL ELECTRIC COMPANY feel happy over the fact that their sales of Packard high-grade incandescent lamps are constantly increasing, and report that there is a great tendency towards using better material in electric light construction. These lamps satisfy the most exacting demands.

MR. J. GODFREY, general manager of the New York Insulated Wire Co., made a short stay in Chicago last week. Mr. Godfrey is on his way to the Pacific Coast, and he keeps catching orders for Grimshaw wherever he goes.

MR. GEORGE E. C. JOHNSON'S eldest daughter was married last week to the Rev. J. H. Henry, of Chicago. Mr. Johnson is well known in electrical circles as president of the Lafayette Street Railway Co., of Lafayette, Ind.

FRANK B. RAE, the well-known electrical engineer, of Detroit, was a recent visitor to Chicago.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE

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THE ACCUMULATORS AT THE FRANKFORT ELECTRICAL EXHIBITION.—II.

BY

Dr Paul Schoop

THE Correns plate avoids this drawback, as the bars of the lead grid are of the form shown in Fig. 5.

This grid seems to be cast by means of metallic moulds, using the trick of placing the milling of the lower part of the mould upwards and that of the upper part downwards. Fig. 4 gives an idea of the process, and Fig. 3 shows a grid with some of the active material in place.

The positive and negative electrodes seem to be exactly alike; the mode of connection of the plates to a section is

FIG. 3.

similar to that observed in the old style E. P. S. cell. The plates are perhaps one-quarter of an inch thick, longer than they are high, and are provided at the upper part with two projections for the purpose of suspension. It is now almost universal not to have the sections or plates standing on a frame at the bottom of the containing vessel, but to hang the electrodes, using two wooden boards or two glass plates as supports.

We may here mention, also, the plates of the "Accumu-

FIG. 4.

lator-Actien-Gesellschaft." This concern manufactures the system of secondary-batteries, formerly known as the "Tudor" accumulator. Indeed, this company claim all the advantages for their products that have been claimed during the last year for the Tudor cell, notwithstanding the fact that the manufacture seems to be quite different. This cell was intended to stand at least six years without getting out of regular working order, and to be practically indestructible. Even at the Frankfort Exhibition a positive plate may be seen (carefully enclosed in an elegant box with a glass cover) with the notice in gold letters: "Plate after six years' use", or something similar. Do the promoters of such schemes really believe that people are fully satisfied with such assertions? Would it not be worth mentioning whether this plate, or battery, was used

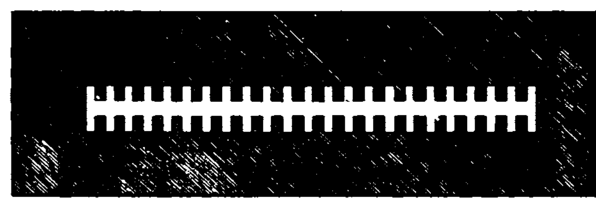

FIG. 6.

daily, and what the daily work was, calculated for the unit of weight and cost? And should it not be necessary, even if such most desirable information could be given, that it be testified to by disinterested people? It seems to the writer that such ways of making a noise (for it is nothing else) are most adapted to make those interested unbelieving and suspicious.

The old style Tudor plate was obtained by pressing lead by hydraulic pressure through a die. Fig. 6 shows a sketch of die, and Fig. 7 a section of the old style of plate. The plate being about one-half inch thick, and the corrugation only about one thirty-second inch deep, it will be obvious that the positive lead plate

FIGS. 7 AND 8.

must last longer than a grid with bars of only one-sixteenth inch diameter. The capacity of such plates was, per unit of weight, only about one-fourth that of E. P. S. plates for instance. Of course, this small capacity had to be enlarged, and in pursuing this purpose the good old plate has been so remodeled that there remains hardly any resemblance to the Tudor. It is very expensive and difficult to form plates of commercial size, say two or three feet broad, by hydraulic pressure, since very large presses would be necessary. It is easier to cast large plates, and this is done by the successors of Messrs. Tudor. The question whether or not pressed and cast lead will behave about the same, seems to be usually considered immaterial, though not by the writer. Instead of corrugations of one thirty-second inch, channels of a little more than one-fourth of an inch are found more practical, in order to augment the capacity per unit of weight, and the so-called Tudor plate of to-day is as shown by Figs. 8, and a six-year-old plate of this pattern after full daily work will probably also be put in an elegant showcase!

The samples of goods exhibited by Mr. J. Hagen, Köln, are most interesting. There are lead castings of such fine workmanship, and of such complicated designs, as to be simply astonishing. Probably these castings were not obtained by means of metalic moulds, but were cast like iron or brass.

Fig. 9 represents a grid for positive or negative plates. Of this pattern there is exhibited a battery of about sixty cells. No doubt the greatest mechanical strength with the

FIGS. 5, 9 AND 10.

least weight of lead is here combined; plugs of active material cannot fall out of such a grid. The castings are without any failures or weak points. It is to be hoped that the cost of making such grids is not too high for general practical use.

Fig. 10 is a grid for both positive and negative electrodes for higher rates of charge and discharge for unit weight of cell.

Fig. 11 seems good for small-sized plates, and for the highest possible rates of current. It seems especially adapted to train lighting, electric launches and power purposes.

Fig. 12 shows a piece of grid for large-sized plates, in-

FIGS. 11, 12 AND 13.

tended for use in batteries for lighting, and Fig. 13 is a piece of grid for largest size electrodes; this sample is a marvel of lead casting. It seems to consist of three separate grids, connected with each other by numerous cylindrical bolts, but the whole is made in one cast.

THE LOCALIZATION AND REMEDY OF TROUBLES IN DYNAMOS OR MOTORS.—VII.

(*Copyright.*)

BY

Francis B. Crocker and S. S. Wheeler.

MOTOR STOPS OR FAILS TO START.

This trouble is, of course, an extreme case of the previous class (Speed too High or Low), but it is made a separate class because it is so perfectly definite and requires somewhat different treatment. This heading does not, of course, apply to dynamos since they are usually driven positively by an engine and do not like a motor, depend on their own operation for their motion.

1. Cause.—*Great Overload.* (See Sparking, No. 1.) A slight overload causes motor to run slowly, but an extreme overload will, of course, stop it entirely or "stall" it.

Symptom.—On a constant current circuit no harm results, and motor starts properly when load is reduced or taken off.

On a constant potential circuit the current is very excessive, and safety fuse melts, or, in the absence or failure of the latter to act, armature would be burnt out.

Remedy.—Turn off switch instantly, reduce or take off the load, replace the fuse or cut-out if necessary, and turn on current again, just long enough to see if trouble still exists.

---

2. Cause.—*Very excessive friction due to shaft, bearings or other parts being jammed, or armature touching pole pieces.*

Symptom.—Similar to previous case, but is distinguished from it by the fact that armature is hard to turn by hand, even when load is taken off. Examination shows that shaft is too large, bent or rough, or bearing too tight, armature touches pole pieces or other impediment to free rotation.

Remedy.—Turn current off instantly, ascertain and remove cause of friction, turn on current again just long enough to see if trouble still exists.

---

3. Cause.—*Circuit open* due to (*a*) safety fuse melted, (*b*) wire in motor broken or slipped out of connections, (*c*) brushes not in contact with commutator, (*d*) switch open, (*e*) circuit supplying motor open, (*f*) failure at generating station.

Symptom.—Distinguished from Nos. 1 and 2 by the fact that if load is taken off motor still refuses to start, and yet armature turns freely by hand.

On a constant current circuit the switch arcs badly when turned on if motor circuit is open; but there is no current, motion or other effect in motor. On a constant potential circuit, field circuit alone of a shunt motor may be open, in which case pole pieces are not strongly magnetic when tested with a piece of iron; if armature circuit is at fault there is no spark when brushes are lifted, and if both are without current there is no spark when switch is opened.

Remedy.—Turn current off instantly. Examine safety fuse, wires, brushes, switch and circuit generally for break or fault. If none can be found turn on switch again for a moment, as the trouble may have been due to a temporary stoppage of the current at the station or on the line. If motor still seems dead, test separately armature, field coils and other parts of circuit for continuity with a magneto or cell of battery and electric bell. (See Instructions for Testing.)

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4. Cause.—*Wrong connection, or complete short circuit of field, armature or switch.*

Symptom.—Distinguished from Nos. 1 and 2 in the same way as No. 3, and differs from No. 3 in the evidence of strong current in motor.

On a constant potential circuit, if current is very great, it indicates a short circuit. If the field is at fault it will not be strongly magnetic.

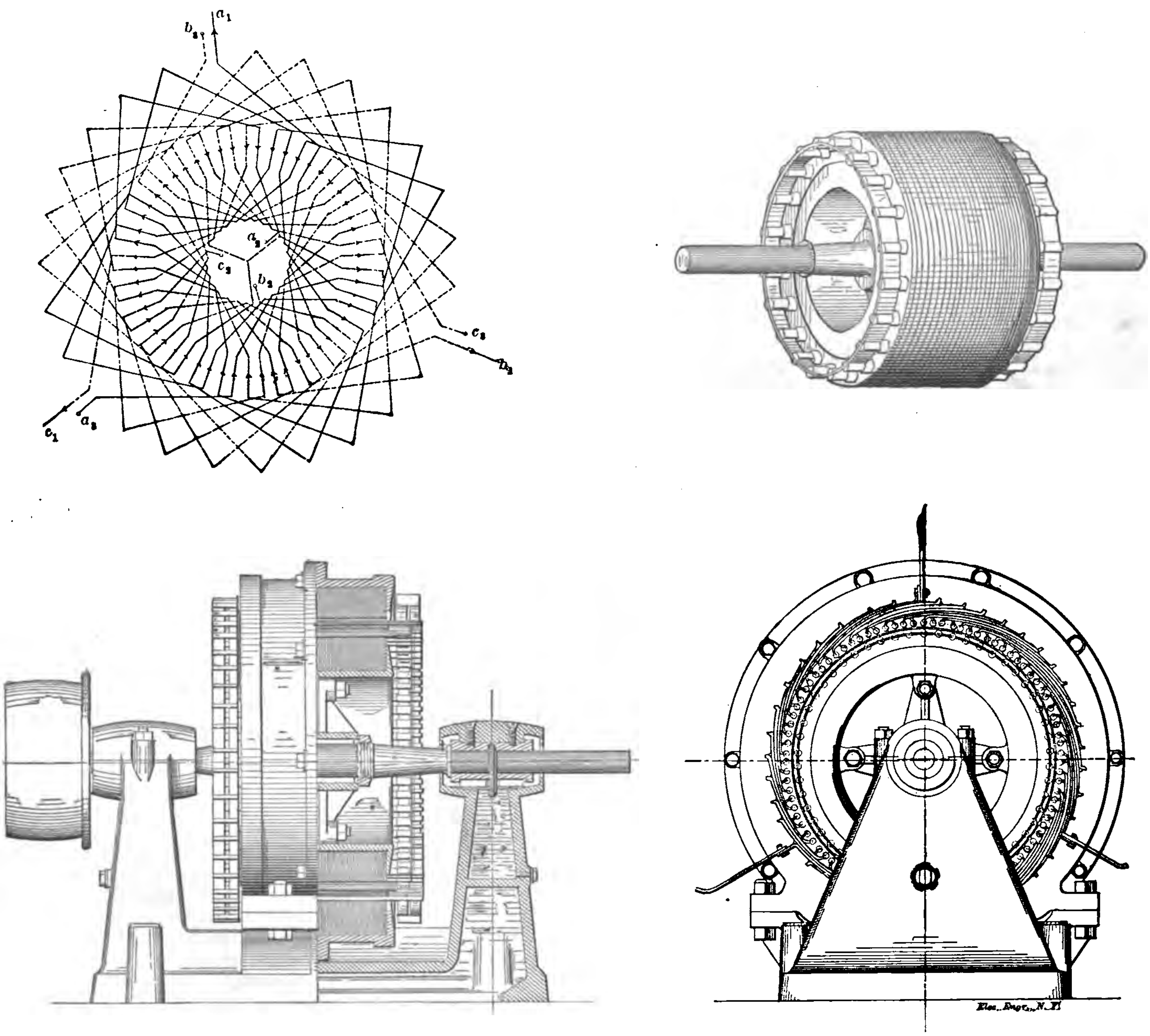
The possible complications of wrong connections are so great that no exact rules can be given. Carefully examine and make sure of the correctness of all connections (see Diagrams of Connections). This trouble is usually inexcusable, since only a competent person should ever set up or change the connections of a motor.

C. E. L. BROWN'S 20 H. P. THREE-PHASE ALTERNATE-CURRENT MOTOR

About the middle of last year Mr. C. E. L. Brown gave his attention to the use of multiphase currents, since the absence of sliding contacts in multiphase machinery is sometimes a considerable convenience, and may in the future be of great importance in the industrial use of electric motors. The Allgemeine Electricitäts Gesellschaft in Berlin were working in this direction, and the Oerlikon is not generally known, suggested the Frankfort-Lauffen experiment; one of these machines being, in fact, employed at Lauffen. The perforated armature in this application offers, among other advantages, the possibility of reducing the magnetizing current to a minimum.

In the accompanying illustrations, Fig. 1 is a diagram of the armature circuits, and Fig. 2, the armature. Fig. 3 is a side elevation and half section of the machine and Fig. 4, an end elevation.

The three armature circuits are connected as in a



Figs. 1, 2, 3 and 4.—Brown's 20 H. P. Three Phase Motor.

Company eventually joined with them to develop this system. In August, 1890, the first multiphase motor on a commercial scale was built after Mr. Brown's design. This machine developed 2 h. p., and had a perforated or "hole armature;" that is to say, an armature in which solid bars of copper are completely embedded in holes in the iron core, the connections being made as in the Gramme ring. In the same month Mr. Brown applied this perforated armature in connection with drum-winding to the 300 h. p. generator and motor designed for the electric transmission of power between Bülach and Oerlikon, which, though it Thomson-Houston armature, and the winding is so arranged that four rotating poles are produced. With 40 cycles the motor makes about 1,200 revolutions per minute. The motor takes 50 volts normally; a reduction to 30, or an increase to over 100, will not make any practical difference in the speed. Of course, in the first case, the heating of the armature wire is greater, and in the second the heating of the iron is increased. The magnetic field rotates, and is produced by the armature reaction, thus avoiding all sliding contacts. The field magnet is composed of a laminated ring with holes, in which are placed insulated copper bars. The free ends on both sides are connected by copper rings. It is not easy to imagine a more simple construction. Before giving results of the trials, however, some general data of the motor may be of interest.

The armature has 90 conductors of about 40 sq. mm. section. The weight of copper is 20 kg., the iron about 100 kg. The breadth of the armature is 20 mm., the outer diameter about 500. The rotating magnet carries 54 copper bars, with a section of 100 sq. mm. The weight of the copper is 15 kg., that of the iron is 70. Recent trials in Oerlikon with this motor showed that it can easily supply 20 h. p. No part of the motor showed with a continuous run a higher temperature than 20° C. to 25° C. above the temperature of the test-room. It may be of interest to mention that the rotating part shows practically no heating. The difference of speed between no load and full load is only about 3 per cent. The torque of the motor at starting is considerable. It easily ran a separately excited dynamo, which was working on a resistance absorbing 20 h. p. Over 200 kg. torque could be obtained on the 20 cm. pulley. The motor can carry also a considerable overload, and runs without the least noise. The starting of the motor is similar to that of a continuous-current motor controlled by a resistance in series with the armature circuit. Regarding the commercial efficiency, no accurate tests have been carried out. The losses in armature copper amount to about 4 per cent. in the magnet copper and iron, inclusive of friction, to 4 per cent. From this there would be efficiency of 92 per cent. A commercial efficiency of 90 per cent. may be relied upon. That the losses are very small is further clearly shown by the very moderate heating, in spite of the small size of the motor and the absence of ventilation. A further advantage is that the commercial efficiency remains high, even if it works on a light load. The weight of the motor is 420 kg., say a trifle over 20 kg. per horse-power. For locomotive purposes it might without difficulty be reduced to 300 kg., the result of which would be only 15 kg. per horse-power. This result must be looked at as a very good one, especially considering the low-current density with which the motor is worked. The bearings are automatically oiled, and contain large oil reservoirs, so that this motor should run without any attention for months.

THE ECONOMIC LIMIT OF LARGE POWER UNITS.

BY "CARLETON."

THIS subject has always been one of deep interest to all persons interested in electrical development, and many electrical engineers have in no way changed their views from the first, concerning the size and style of engine for electrical requirements. No well-organized and regulated gas company would put all of its gas into one holder if such a thing were possible, as an accident in their works would prevent production for a short time, even if the reserve in the gas holders would continue to supply the demand. Let the gas holder be ruined or disabled for an indefinite time, then production and revenue not only cease, but business reputation suffers, a loss of confidence possesses the community and a feeling of uncertainty exists.

The vital question to be considered by electrical promoters is not what a steam horse power costs at its station, obtained from an improved and complicated engine designed to show at its official trial a unit, for a pound, and fraction of a pound, of coal, but what does it cost to produce light commercially at the permanent location of the lamp.

Take, for example, the long-stroke, slow-speed, direct-acting, compound or triple expansion engine, with its multiplicity of valves and intricate connections.

Floor area in places where real estate is of great value becomes the first consideration. Then multiplicity of parts increases the liability of disaster, while variation of load produces internal condensation of steam in the cylinders, caused by constantly changing temperatures, resulting in direct loss, showing a consumption of coal per horse-power per hour in the majority of direct-acting engines to be over five pounds.

Electric railway work is proving to be the most severe problem the steam engine builder ever contended with. Rolling and saw mills were thought to be very exacting in their requirements, but now the yielding of steel and iron billets in their semi-fluid state when entering a train of rolls, as well as the entering of the circular or band saw into the log, passes out of mind when the engine builder knows and realizes that many times during the day the majority of street cars on an electrical railway start and stop simultaneously. These conditions produce a blow on the piston of the engine, which is communicated to the cross-head pin, crank pin, main bearing, and then to the dynamo through the belt. As long-stroke, slow-speed engines, with an independent cut-off for the valves, run with but little if any compression in the cylinders, there is nothing to relieve this sudden blow which occurs twice during each revolution, and the result is quickly seen in the bearings of reciprocating parts, as well as the disintegration and unreliability of belts. The lining metal of the various boxes, which is comparatively soft, yields to the violent and sudden stress put upon it, necessitating frequent driving of keys and adjustment of quarter boxes, accompanied by heat from excessive friction, not only resulting in loss of power, but in increasing the cause of expense and chances of disaster.

It is, without doubt, reliably estimated that the steam horse powers of the world have doubled in the past seven years. This wonderful increase of power has been demanded and required by electrical development, and the shareholder now asks if a permanent and reliable investment can be offered to him, as he realizes that the days of borrowing an engine, boiler and dynamo, together with a few lamps, placing them in some old and almost worthless building, at the same time calling the combination a "Central Station," is a thing of the past. It is to be regretted that numerous electrical engineers are for the sake of personal advancement constantly bringing forward, at the expense of the shareholder, new and untried experiments in special engines. The compound non-condensing engine has had quite a run, much to the disgust of the shareholder who finds with variable load and pressure the direct-acting, non-condensing engine is more economical. As the electrical engineer is without financial responsibilities, the burden of loss is not with him. A recent number of London *Engineering*, the leading and most reliable mechanical paper of the world, says, "Nothing is to be gained by running a non-condensing compound engine, unless it be specially designed, having constant load and pressure." In addition to this authority, it is well known that the Corliss Steam Engine Co., and the Armington & Sims Engine Co., Providence, R. I., builders of long-stroke, slow-speed, and short-stroke high-speed engines, respectively, refused to build non-condensing compound engines. Comment is unnecessary, unless it be to say that these well-known builders are more friendly to the electrical shareholder than his electrical adviser.

The various triple expansion engines which are now attracting considerable attention, have not yet been long enough in operation to judge of their fitness for central station work. They possess many of the objections before mentioned, and their greatest claim for superiority is based on their economical running. The measure of economy of the steam engine is determined on the consumption of steam per horse power per hour. The builder cannot always guarantee the amount of coal to be used in developing a certain amount of horse power, as more boilers evaporate seven pounds than nine pounds of water to a pound of coal, while some of the builders of safety water-tube boilers claim an evaporation of ten and even eleven pounds of water to a pound of coal. Recently, an official test of a triple-expansion engine was made in a well-appointed central station in this country. The published result was a horse power obtained for about 12½ pounds of water. This result was certainly remarkable and unexpected, showing rapid advancement had been made. The publication of the official test showed that an allowance of a certain percentage had been made for saturation of steam by water. What this means and how the result was obtained, the report does not say, and but very few mechanical engineers claim to understand it. Without this allowance for saturation, whatever it may have been, the amount of water actually consumed was about 14 pounds per horse power per hour, and as this amount was paid for, together with the coal used to convert it into steam, the practical central station manager would base his cost of electrical production on the results of 14 pounds, rather than on the theoretical 12½ pounds, which in reality means nothing commercially.

If the required favorable conditions can be given to the properly proportioned and constructed triple-expansion engine, viz., constant pressure, load and speed, then its economical performance cannot be surpassed; but vary the conditions, as in electrical railway work, and the results must be anticipated by the practical manager, without mechanical knowledge. Many of the modern fast ocean steamships claim to produce a horse power with their triple-expansion engines for from 1½ to 1¼ pounds of coal, but as a round trip of these steamers cost $75,000, and the consumption of coal is 300 tons per day, it is of course impossible to obtain reliable data, and the result given is arrived at by estimating. From the Navy Department *Intelligence Series* we find it is customary to estimate the amount of coal consumed on the new cruisers. How can it be otherwise, as facilities for weighing cannot be had? There is, however, the published result of one steamship trial worth repeating. The builders claimed a horse power for their engines of one and one-half pounds of coal. Permission was asked by a professor of a technical college to ascertain if possible the truth of the statement. It was freely given, possibly because it was thought impossible. The ship and engines were reported to be in first-class order and condition. The professor and about twenty assistants carried on their experiments, and after a continuous run of eighteen hours, actual results showed a horse power for two and one-fourth pounds of coal. A claim was then made that the ship and engines were not at their best, but would soon be made so, and an invitation to repeat the experiments was given and accepted. Nearly three years have passed since the first trial, yet the professor has never been asked to continue his investigations, and he never will be although he obtained and gave as reliable data commercial results. They were not wanted. In case of warm bearings, or breakings of parts of the steamship engines, it is an easy matter to slow down, and if necessary to stop for an hour or two, but not so with the triple, expansion street railway engine, with more than double the number of valve-gear parts. *It must not stop.*

Electrical engineers from abroad say we are three years behind them in electrical development, and claim that our large unit system of engines, with belt transmission, is also three years behind modern progress, although these large engines in some parts of the country have not yet started. Let us hope for their success, and that their comparison to the single gas-holder practice may be an unfulfilled prophecy.

To say that the high-speed, high-pressure engine meets all requirements would be absurd, yet it must not be denied that this class of engine has made rapid advancement when it is known that the builders of the first successful high-speed engine in this country were compelled about ten years ago to lay aside for two years their inventions and improvements, owing to intense and not well-founded opposition. It is this class of engine that has more than contributed to doubling the horse power of the world, at the same time compelling the builders of every known kind of engine to run it faster, improve its design and workmanship. It has compelled boiler-makers to use better materials and improve their workmanship, as higher pressures are demanded. It has not only been the means of improving the standing of mechanics, materials and engineers, but it was the pioneer engine that gave commercial electricity its first start, enabling it to get a foothold.

The credit of bringing the high-speed engine into electrical prominence, although a matter of necessity, belongs to Mr. Thomas A. Edison, and an enthusiastic mechanical admirer says: "As was the inspiration of James Watt to steam, so is the knowledge of Thomas A. Edison to electricity." THE ELECTRICAL ENGINEER, April 23d, 1890, is quite clear on this subject, and says: "This is but a return to the original plan of Mr. Edison with his first 'Jumbo' dynamo and the Armington & Sims engine that was sent to the Paris Electrical Exhibition, in July, 1881. This combination is still doing good daily service. It should some day be brought back to this country and placed in the National Museum, at Washington, as it was the first successful combination ever constructed, and should be preserved." The combination should, however, first be placed in the World's Columbian Exposition, to be held in Chicago, 1893, and deserves a prominent place in the Department of Electricity among the first inventions.

Seven of the "Jumbo" combinations are still running in a central station in Milan, Italy, and although antiquated, give proof of the wisdom of the first thoughts of Mr. Edison, that should have been enlarged on by his less able and erratic followers and assistants.

Another pleasing and successful illustration is the Thomson-Houston multipolar dynamo directly connected to the double upright high-speed engine for ship lighting on the Government cruisers and merchant steamers. A large number have been built, and the combination grows in favor on its merits.

Why not continue and proceed on this line of advancement, arriving at the extreme power unit of the future for large central stations, which is to be a compound condensing engine of 500 horse power, with a speed of not less than 200 revolutions per minute, and piston speed of 600 or 750 feet? Stroke should be 18 or 20 inches, which will permit of direct-acting, positive valves, without complication. Armatures should be part of the engine shaft, of as great a diameter as practicable to compensate for the absence of driving pulleys or balance wheel, a most essential requisite. Simplicity reduces to a minimum the liability of disaster. Suppose a central station required 5,000 horse power, then ten 500 horse power engines should be put in, and in case one, or even two of them, or the dynamos are disabled, the remainder would have enough of reserve force to supply all demands unknown to the electrical consumer or customer or until former conditions are restored.

Two of these extreme units would not be suitable for a station of 1,000 horse power, as a number of these combinations of various powers should be placed in each station, and if water for condensers cannot easily be obtained at small expense, then use the direct-acting engine, as about 25 times the amount of water pumped into the boilers for a certain load is required for the condensers. As the engine and dynamo duty increases, add to the present requirements another unit, and when decreasing, take from it permanently, at the same time stopping all expense of that particular unit without destroying its efficiency as a reserve factor.

The managers of small stations should not be carried away with the one gas-holder theory, but build wisely and well for their patrons and shareholders.

MR. J. M. STEPHENS has been appointed superintendent of the Western Union fourth district, succeeding the late Mr. Meriwether.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—XVII.

BY

Chas. Steinmetz.

THE mean value of all the alternate E. M. F.'s of our machines and apparatus, so long as no mechanical commutation is used, equals zero ; that is, $\int e\,d\,t = 0$ and there is no hope whatever of deriving *continuous currents without commutation* except by *electro-dynamic induction* from alternating waves. Every line of magnetic force, which, during a complete magnetic cycle, is cut one way by the electric conductor, must be cut again during the same magnetic cycle, the other way, thereby inducing an E. M. F. of equal but opposite integral value ; and therefore, to get continuous currents from alternate circuits, we have to rely either upon mechanical commutation, or look out for something else still unknown. Electro-dynamic induction can *not* give it.

The E. M. F.'s of the spark-inductors have the same property, but the mean values of pulsating currents are other than zero. Hence, while true alternating currents are unable to produce continuous magnetism without commutation, pulsating currents do so.

The most important non-sinusoidal currents, however, are the *interrupted current* and the *pulsating current.* The *pulsating current* can be considered as a superposition of a continuous current upon a true alternating current, and will, for graphical treatment, best be broken up into these two components, the alternating part of it giving the induction-affects, and the continuous part of influence only so far as it changes the apparent magnetic susceptibility of the circuit, the magnetism fluctuating around a positive average value.

A more complete explanation of the phenomena of pulsating currents, and of the interrupted or intermitting current, we must leave to another occasion, and give only the result here. "*The curve of* E. M. F.'s, *induced by intermitting or interrupted currents, is represented in the polar-diagram by the loxodromic curve,*

$$e = A\,\varepsilon^{-\frac{2\pi t}{T}\cot\Theta}$$

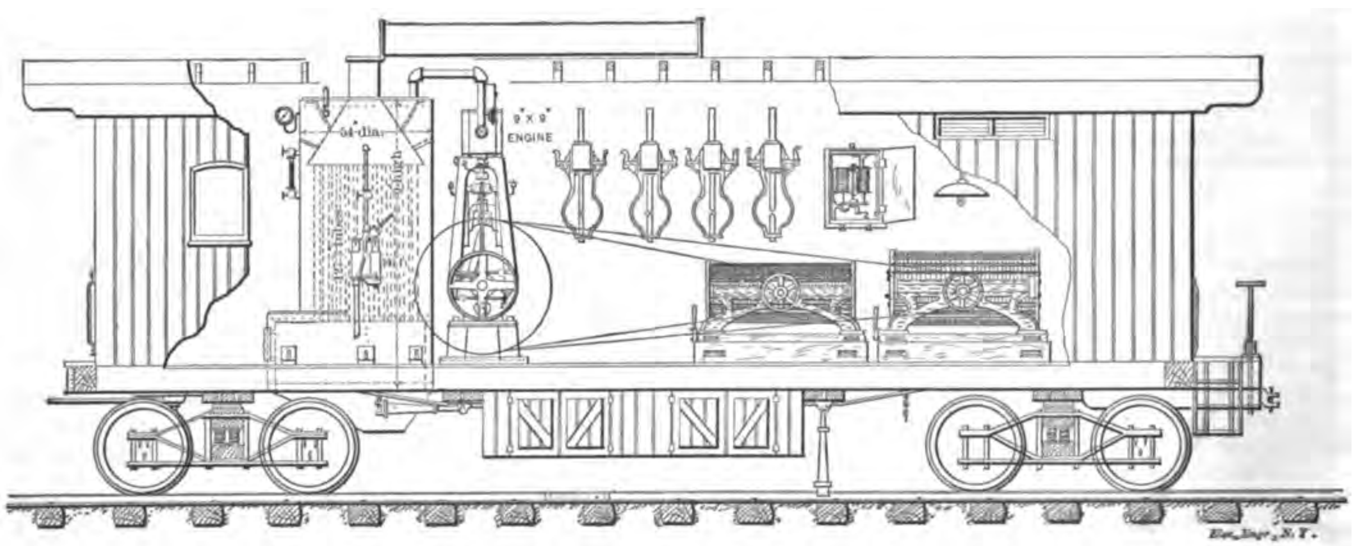
that is, that curve, which intersects all the radii vectores under the same angle Θ, this angle Θ being determined only by number of turns, electric and magnetic resistance, and frequency."

This loxodromic curve shares with the sine-wave the feature, that all the currents, E. M. F.'s, *etc, produced or induced by loxodromic curves are loxodromic curves again,* the original intermitting E. M. F. being represented by the characteristic angle $\Theta = 0$.

But, while the *sine-wave* is the curve of *stationary conditions,* the *loxodromic* is the curve of *disturbed equilibrium.* Hence it appears always, where sudden changes occur.

For instance, when current is thrown on or shut off, a transformer, or when the secondary resistance is changed, the instantaneous values of the electric and magnetic quantities of the transformer travel on loxodromic curves from the diagram representing the former conditions to the diagram representing the altered conditions.

For the loxodromic curve the ratio between primary impressed, and secondary induced E. M. F. is not proportional to the ratio of turns, but entirely independent of it. Therefore the occurrence of sudden loxodromic changes in an alternate-current apparatus may introduce the danger of destruction by excessively high induced E. M. F.'s.



THE CUMBERLAND VALLEY PORTABLE LIGHTING PLANT.

THE CUMBERLAND VALLEY PORTABLE LIGHTING PLANT.

BY

C. H. Hull

HAVING recently read of portable electric lighting as being a new scheme, I send you prints of a portable electric light plant designed and built by me for the C. V. R. R. Co., at the Chambersburg, Pa., shops, in 1883, and which has been in constant use up to date. The accompanying illustration explains the construction. We use this plant for lighting at wrecks, and rent it for pic-nics, camp-meetings and often for public lighting. The capacity of the plant is forty 2,000 c. p. and two 65 c. p. incandescent series lamps.

This plant consists of a fifteen 2,000 c. p. lamp dynamo, built by the Thomson-Houston Electric Company, 1880, purchased by our company in 1882 ; a twenty-five 2,000 c. p. lamp dynamo, spherical type, purchased in 1886, operated by a 35 h. p. vertical automatic engine and a 40 h. p. vertical submerged flue boiler, built by the Taylor Mfg. Co., Chambersburg, Pa. The plant has given entire satisfaction.

A USEFUL HORSE POWER DIAGRAM.

BY

Franklin Sheble

THIS diagram gives a quick means of determining the horse power required to haul a given weight at a certain speed, either on a level or on a given grade. It is within the range of ordinary street-car practice, but can easily be extended by other plots, or by finding the power required for a fraction of the speed or weight and multiplying this by the whole number.

The scheme is applicable to determine the resultant of any number of factors, and is that used by Mr. Hering to determine the sizes of wire.

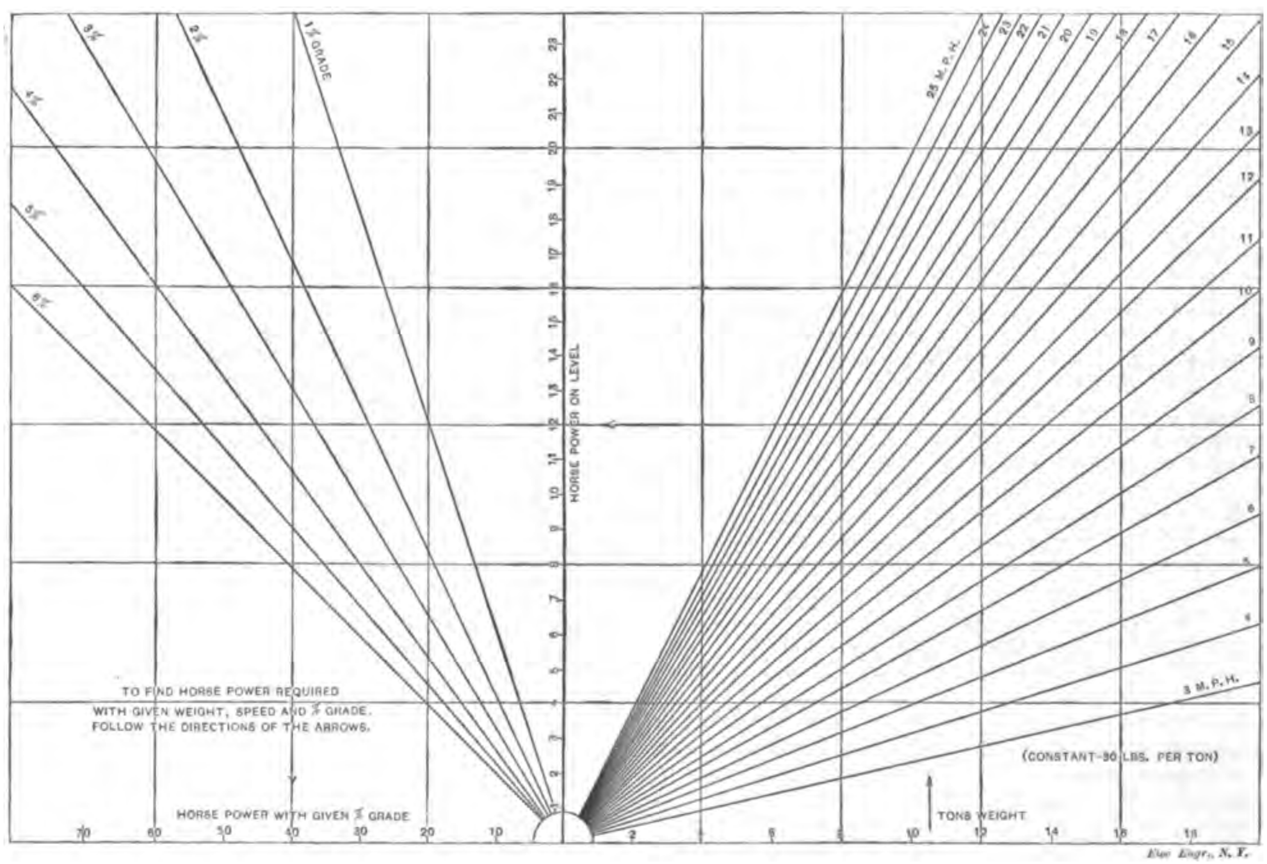
In this case the variables are weight, speed and per cent. grade. The horse-power varies directly as the weight and speed, while the power on a given grade depends on the power required on a level, plus that due to the grade. The formula for horse-power is too well known to need further consideration. The constant for traction here used is 30 pounds per ton.

The following examples clearly show the use of the chart:

1. Suppose the total weight of the car is 20,000 pounds, or 10 tons—following this ordinate to the 15 mile per hour line, and then across, we find that it will take 12 h. p. to draw this car at the given speed; viz., 15 M. P. H. on a level. If it is necessary to ascend a 2 per cent. grade at this speed, we find, by continuing across to the 2 per cent. line and down to the horizontal line, that it will require 28 h. p.

2. Suppose that the car complete weighs 15 tons, equipped with two motors which are capable of delivering 20 h. p. each. Passing upwards on these ordinates we see that on a 6 per cent. grade, 40 h. p. will draw the car at 6.6 M. P. H., on a 5 per cent. grade 7.6 M. P. H., on a 2 per cent. grade 14.2 M. P. H., etc.

3. A motor may be capable of delivering 15 h. p. at 15 M. P. H. This will draw a total weight of 24,500 pounds If it is necessary to climb a 2 per cent. grade the same horse-power will draw this car at 6.3 M. P. H. Two of these motors on the car will, of course, draw 49,000 pounds at 6.3 M. P. H. or 24,500 pounds at 12.6 M. P. H. up a 2 per cent. grade.



THE SHEBLE HORSE POWER DIAGRAM.

HOW IRON MAY BE SEPARATED FROM NICKEL AND COBALT BY ELECTROLYSIS.

So closely allied in many of their properties are the metals iron, nickel and cobalt, that great difficulty is experienced in separating them when they happen to occur together. This difficulty is, says the London *Electrical Review*, dealt with in a new method of separation recently proposed by G. A. Le Roy. The solution containing these metals and also manganese is mixed with a large excess of concentrated and strongly ammoniacal solution of ammonium sulphate after the addition of sufficient citric or other acid to prevent precipitation of the metals. The solution is then electrolyzed with the current from two Bunsen cells (or their equivalent); manganese separates at the anode, and iron, cobalt and nickel at the cathode. The cathode is washed, and is then put into a concentrated solution of ammonium sulphate saturated with ammonia. It now serves as the anode, a weighed platinum plate being the cathode; and when the circuit is closed, the nickel and cobalt are transferred to the new cathode, while ferric hydroxide partly remains on the anode and partly floats in the liquid, but it is free from any appreciable traces of nickel or cobalt.

ECONOMY IN ELECTRIC POWER DISTRIBUTION. REED vs. LEONARD AND THE FACTOR "2 D."

BY

J. Stanford Brown.

ELECTRICAL ENGINEER, XII., No. 177, page 344, Sept. 23, '91, Mr. Chas. J. Reed writes: "In equation (2), for instance, [of Mr. Leonard's paper "Minimum First Cost," etc., ELECTRICAL ENGINEER, XII., No. 174, page 249, Sept. 2, '91], is a numerical error which follows through all the other equations. The numerical factor in the denominator should be 15 instead of 7.5, and the equation becomes $T = \frac{D^2 \times K. W.}{V(E - V) \times 15}$."

ELECTRICAL ENGINEER, XII., No. 177, page 344, Sept. 23, '91, Mr. Leonard replies: "I find that Mr. Reed has fallen into the error of forgetting that we are dealing with a complete metallic circuit, and that we must provide for a conductor both ways. The formula which Mr. Reed gives would give the correct weight of the copper conductor for the distance D, but, of course, for any distance of transmission D we must provide a conductor whose total length would be $2\,D$, so that the equation (2) as given in my article is entirely correct."

ELECTRICAL ENGINEER, XII., No. 178, page 383, Sept. 30, '91, Mr. Reed rejoins: "He (Mr. Leonard) starts out with an arithmetical error and in his reply adheres to the error, insisting that it is correct. I will call his attention to it specifically. In his expression for the weight of the conductor he uses M, the area of $2\ D$ as a factor, and then introduces the factor "2," again, giving the weight of a conductor $4\ D$ in length."

ELECTRICAL ENGINEER, XII., No. 179, page 410, Oct. 7, '91, Mr. Leonard explains: "Formula (1) determines the cross-section of the conductor in circular mils. In order to get this cross-section it became necessary to consider the resistance of the total length ($2\ D$) of the conductor both outgoing and returning; this introduces the factor $2\ D$ for the first time. Having now obtained the cross-section M of the conductor, we next get its weight per foot, and then to get the weight of the total length of conductor both ways we must again multiply by $2\ D$. This introduces $2\ D$ for the second time."

Mr. Leonard's equation referred to, so far as the point in question is concerned, is entirely correct. A different way of explaining the matter may however make it clearer to those who have failed to comprehend it.

If the resist. of 1 ft. of wire of 1 mil area $= R = 10.7$ ohms (H. W. L.).

Therefore " $2\ D$ ft. of wire of 1 mil area $= 2\ D.\ R$

" " $2\ D$ " " (M) " $= M. 2\ D.\ R$

" " 1 ft. " " (M) " $= \frac{M. 2\ D.\ R}{2\ D}$

or the resistance *per foot* of (M) area $= M.\ R.$

Again:

If the weight of 1 ft. of wire of 1 mil area $= F = .000,003,027$ lbs.

Therefore " $2\ D$ ft. of wire of 1 mil area $= 2\ D.\ F.$

" " $2\ D$ " " (M) " $= M.\ 2\ D.\ F.$

" " 1 " " (M) " $= \frac{M.\ 2\ D.\ F.}{2\ D}$

or the weight *per foot* of (M) area $= M.\ F.$

In fact it should be evident that resistance *per foot* is independent of the total number ($2\ D$) of feet even though in getting resistance of (M) one had to consider the length $2\ D$ in order to have the same volt loss in a foot of (M) area as in a foot of 1 mil area.

The $2\ D$, then, taken in by Mr. Leonard in getting the value of M, really canceled out again, so that *taking it in for the second time, only left it in once.*

STREET RAILWAY WORK IN PORTLAND, OREGON.

BY

Arthur C. Robbins

SINCE November, 1889, electricity as the motive power has been adopted by three of the street railway companies of Portland. An aggregate of 32¼ miles of track is now operated in this manner, and an additional 32 miles is being converted into electric roads, or is under proposition to that end.

The City and Suburban Railway have been using electric motor cars since November, 1889, and are now operating 15 miles of road in this manner. They still have 15 miles of steam road on the east side, which is to be changed to electricity as soon as possible; and on the west side the Third street line, consisting of 17 miles of horse line, is already under transformation to an electric service. Thomson-Houston, Sprague and Westinghouse motors are used by this line. They have 18 cars in present use. The heaviest gradients of this road are 200 feet of 11 per cent., with another 200 feet of 9 per cent., from which no trouble is experienced. The generators used are two Edison and two Thomson-Houston, operated by one 16 x 16 Ball, and two 16 x 24 Russell engines. Power for the Third street line will be furnished by the Union Power Company.

The Metropolitan Electric Railway Co. have been in operation since January, 1890. Their route consists of 2¾ miles double track on Second, First and Front streets, with an extension of three miles single track southward to the cemeteries outside the city limits. Their funeral train service seems to be very satisfactory, and they have recently ordered two additional funeral cars from the Columbia Car Works.

This road has 200 feet of 8 per cent., and 400 feet of 7 per cent. consecutive gradients. They are at present operating 18 motor cars, one of which is used across Madison street bridge in connection with the Mount Tabor steam road, for which electric motive power is under consideration. Westinghouse and Sprague motors are in use on this road. The current is supplied by four 70 h. p. Edison generators at 500 volts. The engines used are single non-condensers, one 16 x 16 Ball and one 16 x 18 Beck being required. The double-track cars are making 120, and the single-track 60 miles daily, under a six-minute headway.

The Multnomah Street Railway has been in operation since March 26th, 1890, and now has something over nine miles of double and single track road on Washington street and branches. Their heaviest gradient is 400 feet of 7 per cent. They have 17 motor cars equipped with the Edison system, and 10 interchangeable summer cars. One hundred and eight miles is a day's run on this road. Power is supplied from a 175 kilowatt dynamo at the Union Power Company's plant. They also have in reserve the power plant formerly used, consisting of two 100 h. p. Taylor boilers; two 80 h. p. Beck engines, and two No. 20 Edison generators, which are kept ready for immediate use in case of emergency. The company are justly proud of their record which shows only one interruption since they have been in operation—caused by the breaking of the driving rope.

The Union Power Company have recently entered the field for supplying current for power purposes, and it is said that they have the most perfect steam plant equipment on the Pacific coast. It consists of 10 boilers, one 1,000 h. p. compound-condensing Corliss, and one 500 h. p. Buckeye engines, to which generators are being attached as required. Their fuel supply is derived from a large saw-mill, and is handled from the saw to ash pans entirely by mechanism.

The Columbia Car Works was organized less than a year ago, and has recently removed to the old exposition building, occupying nearly an entire block, two stories in height, where they have room for 48 cars. The capacity of the Works is limited, and I am informed that they have recently been obliged to decline an order for 26 cars from want of facilities for manufacturing promptly. Their force now consists of 25 men, which will be doubled as soon as machinery ordered can be put in operation. They now have nine motor cars in process of building, including two funeral cars for the Metropolitan Company. The funeral cars will be 34 feet long over all, double-truck and single-reduction motors, with a seating capacity of 44 passengers. Six of their cars are now running on the West Portland and two on the Metropolitan roads. They have orders from the Point Defiance Electric Railway, of Tacoma, Wash., and for one car for Boise City, Idaho. The cars complete, including trucks, are made by this company.

"THE MOST CONCISE REPORT."

A LEADING electrical engineer and contractor in Canada writes us: "Let me congratulate you on the appearance of your Convention number, which contains the most concise report of the proceedings in full, in the handiest possible form."

REPORT ON UNDERGROUND WIRES FOR THE DISTRICT OF COLUMBIA.

THE report of the board, composed of Mr. Andrew Rosewater, Mr. Henry A. Rowland and First Lieut. Francis R. Shunk, Engineer Corps, appointed by the President under due authority of the District appropriation act approved August 6, 1890, to consider the location, arrangement and operation of electric wires in the District of Columbia, has been placed in the hands of the President.

The report itself is a long and able document and it is accompanied by a voluminous mass of charts, tables, diagrams and exhibits of various kinds. The report sketches first in a general way the investigations made by the board and the general results of the correspondence of the board with the telegraph companies and others interested. It then goes into an interesting discussion of the manner in which the underground problem has been dealt with in various cities and then proceeds to treat of the situation in Washington. It starts out with the broad and definite proposition that "all future conduits shall be built, owned and controlled by the District," and to that end has prepared plans, in which practical approval is given to the Lake and Lynch system of vitrified clay conduits, recently described exclusively in THE ELECTRICAL ENGINEER. The report says :—

"These plans provide conduits with a minimum capacity of four ducts to a maximum of sixteen ducts. For purposes of uniformity and economy we recommend the location of signaling and alarm stations, as far as practicable, at the southeast corner of the intersections, within reasonable distances apart. These stations can and should be combined with an electric light pole of approved artistic pattern, so as both to economize space and avoid useless expenditure. The plans and estimates are based upon the rectangular vitrified glazed clay conduit, which has been heretofore referred to, and has been found from sufficient trial in the District to meet all the requirements. It is not as cheap as the creosoted conduit systems in use in Philadelphia or Brooklyn, but if encased, as provided, in concrete, its construction will be of a permanent character without liability to partial combustion by electric leakage in accidental cases of injury to the cable. On the other hand, its cost will be less than iron or other material and its relative capacity of ducts greater.

"The details of construction have been only outlined for general estimates, as they will vary with every block and relative position to the gas, water and special electric service pipes and conduits.

"The important features in the construction of this system are: First, a permanent and uniform base of concrete (6 inches is a fair thickness); second, the careful laying and alignment of the sections so as to insure true lines and continuous ducts; third, the proper bedding and encasing of each tier of sections in a uniform layer of small stone or gravel concrete; fourth, the proper construction of the manholes with a good coating of cement mortar or concrete from the base up to the top, to render them impermeable both to moisture and gas as far as practicable; fifth, the efficient ventilation of the manholes through lamp connections; sixth, provisions for tight, close-fitting covers and plug or valve sewer connections to manholes in the lower section of the city liable to overflow or subject to back water, and ventilated covers with open trapped sewer connections for manholes in the upper section of the city.

ESTIMATE AND COST.

The following is an approximate estimate of the length and cost of the conduits and manholes comprising the system:

219,800 lineal feet or 41.54 miles duct conduit....	$241,230
50,100 lineal feet or 9.49 miles 8 duct conduit.....	105,210
17,600 lineal feet or 3.33 miles 12 duct conduit....	52,800
11,600 lineal feet or 2.20 miles 16 duct conduit....	46,400
	$445,640
298,600 lineal feet or 56.56 miles, allowing 10 per cent. for contingencies and supervision........	44,564
	$490,204

Total length of ducts, $317\frac{68}{100}$ miles. Cost per mile, $1,543.

"Considering that after construction it will take several years to fill all the ducts and the cost of maintenance and supervision, we regard that 7 cents per lineal foot per year for each duct used as a reasonable rental for the first few years.

"The estimates contemplate manholes on an average of 300 feet apart. Local conditions will make this a variable factor.

"The cost of manholes also varies with the size of conduits, ranging from $40 to $140 each. The figures given will in the aggregate be found sufficiently accurate for purposes of legislative determination.

"Accurate and exact details will necessarily have to be prepared under the supervision of the electrical department after a general plan shall have been determined upon, with special regard to all the governing local conditions of each section of the city.

"In determining the sizes of the respective lines of conduits we have taken into consideration the service already provided for by the telephone and electric lighting companies. The five miles of conduits laid by each of these companies during the year 1891 have been subject to stipulations in the permits hereto appended. We do not regard it unreasonable to require from each of them the free use of one duct in each line of conduit for the public service."

The report concludes with the recommendation that a permanent electrical bureau be created to supervise all electrical work in the District, to consist of a skilled electrician as chief, with a corps of competent experts. It is suggested that a fair salary for the chief of the bureau would be $4,000 per annum, with $2,000 for his principal assistant.

THE WORLD'S FAIR ELECTRICITY DEPARTMENT.

THE Department of Electricity of the World's Columbian Exposition is making every effort to secure among the exhibits in the electrical line a complete collection of historical apparatus. Chief Barrett's assistant, Mr. E. E. Keller, has the matter in hand, and has opened correspondence with parties supposed to have in their possession various apparatus of this kind. The intention is to secure apparatus used by the old scholars in their researches and to combine this in an exhibit showing the progress of the science, from as early a date as possible. There is doubtless considerable apparatus of this nature in existence in Europe and in America, and the problem is to get possessors of such apparatus to place it at the disposal of the Department of Electricity. Mr. Keller is fully aware that this is no easy task to accomplish, and he is anxious to have all persons having a knowledge of the existence of anything in the line of electrical apparatus communicate with him and aid him in the location of apparatus of interest.

The Construction Department is now perfecting plans for the location of restaurants, lavatories, cloak rooms and offices in the Electricity Building for the consideration of Chief Barrett and his assistant.

The location of these conveniences have not yet been definitely settled upon, but the matter will probably be settled in a few days. The classification of the Electrical Department has been completed and is in the hands of the printer.

A recent letter from Mr. Hornsby to Prof. Barrett, written in Frankfort, states that he left there for Nuremburg on the 7th ult. to visit Schuckert & Co. From there he goes to Berlin, Cologne, Breslau, Dresden, Vienna, Buda Pesth, Paris and London, to visit the works of the most prominent manufacturers met at the exposition. He has been sufficiently encouraged there to visit these places. He is already assured of extensive and complete exhibits. Hartman & Braun, of Bockenheim, assure him that they will make a magnificent display of their justly celebrated electrical instruments, etc. Dr. Hoepfner, the well-known electro-chemist of Giessen, was visited, and promised a complete exhibit of his method of electrolytic extraction and purification of copper and other metals. Dr. Werner Siemens has expressed a willingness to make a fine exhibit.

Prof. Ferraris, of Turin, Italy, wishes to visit the Fair, and the Electrical Congress especially. He says that he hopes the date for the Congress will be fixed for August, 1893, as all of the professors of Europe have their vacation during that month, and a better attendance could be had.

Mr. F. A. Haselwander, so prominently connected with the Lauffen transmission scheme, promises to exhibit a street railway conduit, and has made, in connection with Michael Von Dolivo-Dobrowolsky of the same enterprise, an assertion that they are ready to transmit 1,000 to 5,000 h. p. from Niagara to the World's Fair at a pressure 50,000 volts over a bare wire. The Ganz people, of Vienna, talk of running an electric road from the Exposition grounds to St. Louis, making the run every half hour.

A number of letters, telling the location of interesting historical apparatus and relics to be gathered in the historical section, have been received.

SOMETHING NEW IN CAMPAIGN BANNERS.

DURING the recent political demonstration in Harlem the Stuyvesant Democratic Club had a 20-ton truck equipped with a dynamo, engine and boiler, and a large upright sheet of galvanized iron, supported in such a way as to turn in any desired direction. This iron sheet formed the background of a banner, and was pierced with holes through which incandescent lamps protruded and spelled the inscription: "Flower, Sheehan, 1891, Stuyvesant Democratic Club, Harlem, N. Y." The truck also carried a search light and was drawn by eight horses, each horse having lamps attached to the harness. The display was exceedingly conspicuous, and excited much comment.

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EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

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Magnetic flux in fact is not to be enchannelled, because there is no known magnetic insulator, and this fetters by complication the quantitative grasp of the subject.—A. E. Kennelly.

UNDERGROUND WIRES IN WASHINGTON.

FOR some time past, a special commission, composed of Mr. Andrew Rosewater, C. E., Prof. H. A. Rowland and Lieut. F. R. Shunk, has been at work on the preparation of a report to Congress with respect to the placing of wires underground in the District of Columbia. The commission, as we have had opportunities of knowing, has devoted itself to the investigation with unusual diligence, and the report now made bears evidence of a desire to ascertain all the facts bearing upon this very important matter. It is, we believe, the first systematic effort made in this country to gather for the specific purpose all the information obtainable; and while it thus necessarily includes much that is old and familiar, its results and conclusions cannot fail to interest every electrical engineer.

As will be gathered from the abstract which we give of the report on another page, the commission, after a careful examination of the various conduits, has recommended the adoption of the Lynch-Lake rectangular vitrified, glazed clay conduit, of which a very full, illustrated description was recently given exclusively in THE ELECTRICAL ENGINEER. This conduit is bedded in cement. The plans presented provide for conduits with a minimum capacity of four ducts to a maximum of sixteen ducts. It is stated that these conduits, of whose permanence no doubt whatever can be entertained, are not quite as cheap as the conduits of creosoted wood, but cost less than those of iron, such as are in use in New York. For 56 miles of conduit, furnishing 317 miles of duct, the estimated expense is $490,204, or $1,543 per mile—a very moderate figure—although there seems to be an extra allowance for manholes 300 feet apart, at a cost ranging from $40 to $140 each, making, say, another $1,000 per mile. It is not quite clear, however, that this is an additional item in the estimates.

A notable feature of this subway scheme for Washington is the proposition that the District of Columbia shall own them outright and shall make a charge of seven cents per lineal foot of duct per year. In New York we have tried the other experiment of letting the subways be built and owned by a private corporation, which has simply carried out, or has been supposed to do so, the wishes of the Board of Electrical Control. It is early yet to say that the plan is not a success, or that the particulars in which it may have failed are not due to the very peculiar conditions under which the whole subway work was devised and carried out. Possibly this public ownership may work well in Washington, where paternalism finds its practical apotheosis in the absorption by the National Government of all civic functions, but there seem reasons to prefer ordinary methods in such a city as New York. It is, perhaps, the fact that all Washingtonians are wards of Congress that impels the commission to recommend as it does municipal street railway ownership for the District. One is tempted to say that it is none of the commission's business, but if the Congress of the United States determines, on the basis of this report, to go into street railway enterprises and put up its roads to lease for ten-year periods, Mr. Rosewater will certainly have secured for Mr. Victor Rosewater, his promising nephew, who has so tried the souls of electric light managers struggling to earn dividends, a vindication and justification for his social and economic theories which could hardly have been expected by that young Bellamyite. Congress will then, of course, feel equally under an obligation to exemplify its approval of the municipal ownership idea by securing the local electric lighting plants, and all the stage lines, as well as the hackney coaches and hansoms that perambulate the asphalt of the National Capital.

But while we look askance at any plan which would thus divert improperly the proceeds of taxation, we are heartily in favor of the electrical bureau that the report suggests. Public control is infinitely better than public ownership, and there can be no objection to the exercise of a vigilant and comprehensive supervision of all electrical work in every city. One of the best signs of the times has been the appointment all over the country of city electricians or the establishment of electrical boards. The step shows that the importance ef electricity in the community is duly appreciated, while the work of these authorities, if fairly and honestly done, will go far to protect electrical investment and ensure a high standard of electrical equipment. In Washington it is proposed, moreover, that the District Electrical Bureau shall have charge of the fire-alarm and police signal service, to which, as we have already said, it would be unreasonable to object under the circumstances.

MR. EDISON'S RAILWAY INVENTIONS.

Our columns contain this week the bitter protest of a correspondent against the various reports that have appeared in the newspapers with regard to some new work of Mr. Edison in electric railways. It is a matter of fact that, as there stated, the effect of these newspaper articles has been to put a check upon immediate investment in existing methods of electric railway work, and for that reason they are to be deplored. But it is hardly fair to hold Mr. Edison responsible for the exaggerations and bulls crowded into these reports. Some day the newspapers will perhaps employ skilled men on their technical work as they now do on that which relates to music and the drama; but in the meantime we must be thankful things are no worse. If this talk arrests development, the Edison General Co. will suffer with the rest, and even his worst enemies will credit Mr. Edison with shrewdness enough to see that palpable and obvious fact. There is, however, offset to the harm done. It is a great thing to have the whole country talking and thinking about electric railroads, for in due course misinformation will be corrected and the truth shine clear. Having tried ourselves for ten years past to engage public attention on electric railroad work, we are glad to see that the subject is now ripe for a nation's thought. If Mr. Edison, too, can add to existing methods one by which low voltage may be used, it is cause for general congratulation, even though to many of us lowering voltage looks like a decided step backwards. We are all gainers by every extension of the field, and in the long run not a cent less will be spent in railway investment. Moreover, there is no evidence that existing methods or apparatus will be wiped out, even by the most revolutionary invention. Each new invention simply restricts other ways of reaching results to their strictly legitimate sphere of greatest profit and benefit; and as far as electrical plant is concerned, the depreciation is generally so slight that, even in spite of the great advances made, apparatus is still running with satisfaction that belongs to the very early stages of the art. In a word, we do not see the slightest reason why any single railway project entered upon or even broached should not be carried to a conclusion. When Mr. Edison puts his plan on the market it will be time enough to discuss its actual effect.

IMPROVING THE SIGNAL SERVICE.

Brig-Gen. W. A. Greely, Chief Signal Officer, in sending his annual report to the Secretary of War, has made an appeal for means to improve the military field telegraph system. The fact is that this country has fallen very much behind in this respect. The armies of England and the Continent are to-day expert in the use of the telegraph, the telephone and the electric light for purposes of warfare; and the unsettled state of affairs on the other side of the Atlantic acts unceasingly as a stimulus to the evolution of new ideas and methods of conveying intelligence. But it is within bounds to say that in this country no advance has been made upon the achievements of the Civil War; and while the Signal Corps may be expert in the use of the telegraph, we believe that it has had virtually no experience at all with the telephone and the electric light when utilized for operations in war. Pointing to the prompt adoption of these new aids abroad, Gen. Greely says: "The results of such inventions are quickly applied in foreign armies to the solution of professional questions arising in connection with military duties, and if the professional standing of the American army is to be maintained, similar application must be made in this country, otherwise a few years would leave the entire army unskilled in the most important of modern appliances." So little do the authorities at army and navy headquarters appreciate this truth, that, as we complained recently, such men as Sprague, Fiske and Murdock are sent off on old ships to the far ends of the earth, while others, such as Duncan, Greene, Crosby and Shallenberger, quit their profession to seek an avenue for merit and aptitude in various electrical vocations that were not contemplated in their training at West Point or Annapolis.

THE ECONOMIC LIMIT OF POWER UNITS.

It is the fate of all good things to run to extremes, the inevitable result of which is that a reaction sets in sooner or later, which in its turn goes to the other end of the scale, and this sort of oscillation continues until a rational medium is reached. Even the medium is a function of more or less variable circumstances.

Nowhere has this tendency been more marked than in the case of power units. It having been proven that a large steam engine could be run with greater economy than several small ones under certain conditions, there has been for the last few years a movement in favor of larger and larger units until of late the economic limit appears to have been exceeded, and a return to the old practice seems imminent.

In view of these facts the paper by "Carleton" on another page is especially timely, and cannot fail to be highly interesting to every central station manager, and, for that matter, every stockholder of an electric light or power company. An intelligent consideration of existing conditions is of the very first importance, and "Carleton's" simple and masterly handling of his subject is well calculated to impress many who might otherwise be led away by popular opinion. Our contributor, who is admittedly one of the foremost men in the steam engineering profession, whether in this country or in Europe, has put his points very strongly and we do not expect that all our readers will agree with him. But what he argues was worth saying and is opportunely said.

The Electrical Congress of 1893.

It is encouraging to see that the proposed Electrical Congress at Chicago in 1893 is already arousing much interest. That Congress must be an honor to the electrical profession in America, and too much time and thought cannot be bestowed upon its plan and details. Not only has work begun in Chicago, but the American Institute of Electrical Engineers, as the national technical body, is already following up its action of the past two years by organizing for an active campaign, and has appointed Messrs. Anthony, Hering and Kennelly to formulate a programme that it may suggest as the basis of the proceedings of the Congress.

MAGNETIC RELUCTANCE.[1]

BY A. E. KENNELLY.

THE science of magnetism was a collection of facts concerning magnets until Coulomb first brought to light a quantitative relation between a few of its phenomena, and thus entitled it to appear among the exact sciences. He determined by measurement that the forces of attraction or repulsion between the poles of long, thin bar magnets were proportional to the strengths of those poles and inversely to the square of their intervening distance.

In one respect, it has since been shown that the discovery was unfortunate, for it served to depress rather than to stimulate further inquiry into the laws of quantitative magnetic relationships. The application of Coulomb's law soon brought into use a conception of magnetism, suggested perhaps by the analogy the law bears to that of gravitation force. This was the hypothesis of a layer of fluid or imponderable matter resident on the surfaces of magnetic bodies and endowed with attractive and repellent forces on all portions of such fluid, in exact similarity to the two-fluid theory of electricity. Each element of surface magnetism would exert according to Coulomb's law a definite force upon every other element of its own, or of other magnet surfaces, and when the distribution of the magnetic matter or fictive layer was known, the total forces active between the magnets forming the system could be determined by the summation of all the elementary actions. This was the polar conception and mathematical theory of magnetism. It was not only artificial; it was also misleading. It assumed that definite action could be exerted at a distance, ignoring the action of the intervening medium. Nevertheless, a slight modification of the polar theory rendered it capable of expressing a mathematical theory of magnetism with apparent success, and exhibits in this respect, like the theories of gravitation, the remarkable construction of purely artificial frameworks of thought, void of all attempt at reality, yet capable of affording useful applications and exact quantitative results, while beneath their foundations the real and natural active forces still lie in undiscovered concealment.

It was soon apparent that magnetism considered as a fluid could not be confined to the surface of bodies, since it was only necessary to break a bar magnet asunder in order that new poles and new magnetic fluid should be exhibited. The amendment to the original theory was then framed that a condition of molecular magnetization extended, veinlike, throughout the substance of the magnet. The termination of each vein at the surface exposed a definite quantity of polarized magnetic matter, while within the veins the polarity was neutralized by the successive layers of opposite molecular poles. This was a great stride beyond the original theory, for it ascribed magnetism not alone to a fictive superficial layer, but to the combined effects of all the molecules in the magnetized body, whose substance, no longer a mere frame for supporting the layer, became invested throughout with a definite condition.

The amendment in time became classical, and subverted the original conception, for the polar theory only recognized superficial magnetism, while the vein theory did not make any such reservation. It was only necessary to assume that the veins varied in richness at different parts of the magnet, or that they might be subjected to faults and partial discontinuities, to introduce unneutralized polarity within the mass which might be capable of exerting external influence, a condition neither the simplest nor most usual, but which the experiment of superposed magnetizations in steel has rendered familiar. This irregularity of vein structure would add a volume distribution of magnetic fluid through the interior of the magnet to the surface distribution on the outside.

On the vein theory, the intensity of magnetization at any point of the magnet would be defined as the amount of magnetic matter cut through in the veins per unit area by a plane section perpendicular to their direction, at the point in question.

A unit magnetic pole, situated in free space, at the end of a very long thin bar magnet would by definition repel with unit force a similar pole one centimetre distant—that is, resident on the surface of the sphere one centimetre radius, of which it occupied the centre. The surface area of this sphere would be 12.57 (4π) sq. cms., and over all this surface the pole would thus establish a magnetic field of unit strength and exert a magnetic stress equal to unity. Each square centimetre of the surface bounds an area of stress which emanates from the pole, and consequently the latter must emit 4π units of stress flux. In the language used by Faraday, it would throw off 4π lines of force. This stress flux has somewhat unfortunately received from Maxwell the name of induction, and the induction through the surface surrounding the pole would be 4π units.

The interest connected with the nature of this stress demands a moment's pause at this point. While its real character is still as great an enigma as the real character of magnetism itself, some of its laws are well understood. There exists along the direction of the stress a tension accompanied by a general pressure at right angles, just as in the case of stimulated muscular fibre, which tends to shorten and expand laterally, or, as it is generally expressed, the lines of force tend to contract while repelling one another. Since the time of discovery that the plane of undulation in polarized light waves twists in passing through certain magnetized substances it has been supposed that the stress might be of a rotatory character. Like an incompressible fluid, it can neither accumulate nor vanish locally, and as much stress flux must leave any region as enters it, if no magnetic pole exist within the confines. Its intensity is very remarkable for it is far in excess of any stress that we can exert without the aid of cohesion in matter. This may be judged by comparing the quantities of energy that can be stored in a given volume of space—say air space. It is, of course, easy even without the assistance of iron to magnetize a cubic centimetre of air to a flux density of 5,019 C. G. S. lines when it will possess an energy stored up in magnetic stress of one megalerg (1,000,000 ergs or 0,0737 foot-pound) while if this magnetization be alternated 227 times per second the average rate of absorption and discharge would be 45.5 watts, and one cubic inch of this air would stow and release energy with the average activity of one standard British horse. Under electrostatic stress, air not in the immediate neighborhood of a conductor appears to break down when the E. M. F. per linear centimetre exceeds 32,000 volts or 110 A. E. S. U., so that the maximum electrostatic energy that one cubic centimetre will hold without rupture is about 500 ergs or two thousand times less than that resident in air stressed magnetically to 5,000 lines, while a cubic centimetre of air near the earth's surface illumined by bright sunlight does not hold more radiant energy than about fifty microergs.

An alternating current transformer is a device in which the secondary coil absorbs the energy out of air and iron, pervaded by the stress flux from the excited primary coil. Unfortunately while magnetically stressed air yields, so far as we know, all its stress energy back into either the primary or secondary circuit, stressed iron fails to do so entirely, and absorbs energy at every cycle, a process known as absorption by hysteresis. The iron directly converts the magnetic stress energy into heat energy, just as a spring absorbs some of the energy imparted to it during every cycle of compression and recoil.

These 4π units of stress flux are not confined to a spherical surface of one centimetre radius, but would be found by summation over any enveloping surface containing a single unit pole, just as the delivery of material liquid must be the same in a steady stream at any section of its course independent of the channel area there existing; for at ten times the distance, the spherical area would be 100 times greater and the stress by Coulomb's law 100 times less, leaving the total area of total stress unchanged, and it follows in fact that the stress flux over any boundary is always 4π times the strength of pole enclosed, no matter whether that pole be alone in space, or be the sum of any number of magnetic systems, in molecules or in masses.

On the vein theory, however, the strength of a pole is the quantity of magnetic matter on its surface, assuming that the veins meet it perpendicularly, or it is the aggregate surface intensity of magnetization, so that the stress flux through each unit of polar surface is 4π times the intensity of magnetization. This is true not only for the polar surface, but also for the interior of the magnet, and every unit vein of magnetic polarized matter carries associated with it a stress flux of 4π.

The magnet may itself be situated in a field of force so that its substance may be pervaded by a stress flux independent of that in its veins. It may and generally does happen that part of this separate stress flux issued from its own poles, in which case it will enter in the opposite direction to the vein or internal flux and will tend to reverse the molecular polarity of the vein structure, but whenever such additional flux is present, the resultant total flux at each point will be the geometrical resultant of that in the veins compounded with the external flux by the parallelogram of forces. In the important case of a long bar of homogeneous soft iron submitted to the influence of a uniform magnetic field acting in the direction of its length there will be a uniform induced molecular polarization or magnetization set up along the bar. Suppose for instance a bar of iron five square centimetres in uniform cross-section pointed in the direction of the dipping needle near Paris. The earth's field there being 0.46 unit, or its stress flux 0.46 units over each normal square centimetre, that stress would be active in setting up polarity in the molecules of the iron along the bar. The degree of magnetization would be also influenced by its own resulting polar stress unless this effect could be rendered insensible by sufficiently extending the length and thus carrying the poles out of the field. With a very long bar magnet the magnetization would be everywhere about 40 times this strength of field, or numerically 18.4 units, and on the vein theory there would therefore be 18.4 units of magnetic matter exposed on the surface of each square centimetre in a slice made across the bar at any point or 92 units over the whole section. The polar surfaces would also be covered by 92 units of positive and negative matter respectively. Associated with each unit vein of polarity, however, would be 4π units of stress flux

1. Read before the American Institute of Electrical Engineers, Oct. 27, 1891.

giving a total flux of 1156 units in the bar which would emerge from the polar surfaces and unite in surrounding space. The whole induced system would, however, be immersed in the earth's field that evoked it and which would be superposed upon it throughout. There would thus be 1156 + 2.3 or 1158.3 units of flux in ordinary phaseology 1158.3 lines of induction through the bar, a density of 231.6 C. G. S. units per square centimetre. The law that the whole flux is the field flux compounded with the induced flux of 4π times the magnetization, which holds uniformly at all points throughout the bar in this simple case is true at any individual point in the most complex case, however variable the field or magnetization may be.

The fact that the stress flux has the same total value over any envelope surrounding a magnetic pole, however widely the stress may be diffused and rarefied, that it follows curves in space whose existence can be rendered evident by iron filings and curves that form closed loops through the substance of the magnet itself, gradually suggested the notion of a magnetic circuit in which the circulation was neither a fluid nor an energy-exchanging condition like a current but a stress.

This conception once firmly established proved of great advantage. Not only has the dynamo been greatly aided in development by the applications of this theory, but the inter-relationship between magnetism and electricity has been brought into clearer recognition in consequence. From this point of view the ideas and analogies of the galvanic circuit became paramount and eclipsed the original notions of magnetic matter and magnetization. All that was essential on this hypothesis was a magneto-motive force in a circuit having conductivity, and a flux or magnetic current resulted. The magneto-motive force in permanent magnets was the result of a definite molecular condition in the iron, while in the neighborhood of an electric current it was always active. According to Ampere's theory that magnets had molecules in which electric currents ever circulated, the two sources of magneto-motive force were united.

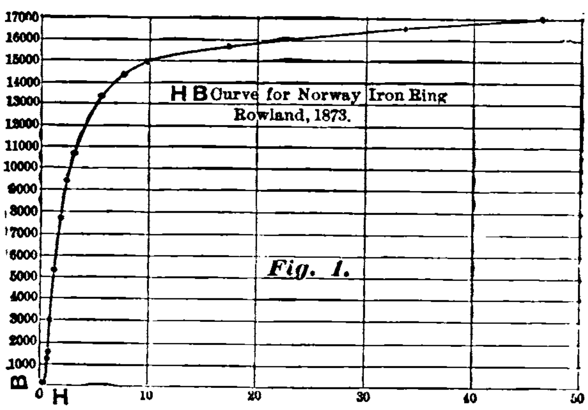


Fig. 1.

Some contention took place between the claims of the vein theory and the circuit theory for the interpretation of magnetic phenomena, and the question as to their relative merits is yet often raised. It seems, however, early to decide upon the acceptance of any theory while the ultimate origin and nature of magnetism remains unexplained, and it is better to regard both theories as working hypotheses to account for the effects of magnetic laws, equally capable of yielding correct results and therefore closely associated, while the preference between them will depend upon the nature of the problem to be attacked. The circuit theory is the simpler for general purposes of theory and particularly for dealing with the phenomena of electro-magnetism. The vein theory, on the other hand, while very artificial, is often more convenient in dealing with the magnetic behavior of the three metals iron, cobalt and nickel, and it is the natural accompaniment of Ewing's modern theory of magnetization which at present appears to best represent the facts.

On the circuit theory the magnetic-conductivity of all substances is very nearly the same as that of an air-pump vacuum, and constant, notably excepting the three magnetic metals whose conductivity is enormously greater, but variable with the conditions of the circuit.

The existence of magnetic conductivity known as "permeability" necessarily involved the inverse quality of magnetic resistance.[1] Some debate has taken place as to the validity of this term or its application for the reason that the resistance which usually enters into practical magnetic circuits is generally far more variable than that found in the metallic circuit of electricity. It is now generally admitted, however, that the term magnetic resistance is fairly applicable in virtue of analogy if not of exactitude. The term magnetic reluctance then suggested by Heaviside, has however the advantage that "reluctance" as one word is less cumbrous than "magnetic resistance," and for that reason only it is advantageous to retain it. Similarly the reluctance per unit volume or the magnetic resistance of one cubic centimetre has been called "reluctivity" and is perfectly definite if not quite euphonious under that title. It is this quantity which will occupy our further attention.

1. Bosanquet. *Phil. Mag.* Vol. xxv, 1888, p. 419.

This magnetic circuit differs from the galvanic in one important particular. In the latter we most frequently meet with a conductor carrying the flux or current through an insulating medium such as air in which no current—certainly no measurable current—passes. In the magnetic circuit this condition of things while approximated to and often for practical purposes assumed in dynamos or electromagnets is only realized in one actual instance—that of a closed Faraday ring uniformly wrapped with wire carrying a current. In every other real case the flux is diffused more or less through the surrounding substances and does not follow a simple passage. Magnetic flux in fact is not to be enchanneled because there is no known magnetic insulator, and this fetters by complication the quantitative grasp of the subject.

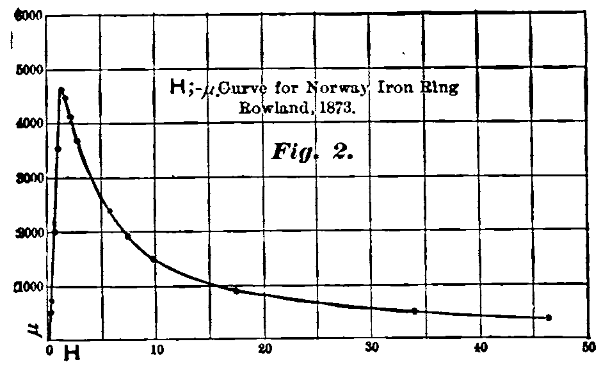


Fig. 2.

The law of the magnetic circuit is like Ohm's law that the flux is equal to the magneto-motive force divided by the reluctance. That is regarding the circuit as a whole. For any one point of the circuit the law is that the flux density is equal to the drop in magneto-motive force per centimetre, there existing, divided by the reluctivity—corresponding exactly to the case of Ohm's law at any point in an electric circuit. This "drop" is called the magnetizing force, denoted by H, and is the strength of the magnetizing field at the point. Owing, however, to the great variation that exists in the reluctivity of iron which enters into nearly every practical magnetic circuit, the law is of much less service than Ohm's electric law. The reluctivity depends not only on the magnetizing force, but also on the degree of purity of the iron, and iron possessing 12 per cent. of manganese is almost non-magnetic.[1]

A number of attempts have been made by different observers to establish a definite relationship between the flux density and the magnetizing force or the permeability in order to so amend the magnetic Ohm's law as to give serviceable results for even pure iron. The results obtained, excepting the formulæ of Frölich and Lamont, have generally been regarded as unsatisfactory. They have usually been expressed graphically as curves in one of three types:

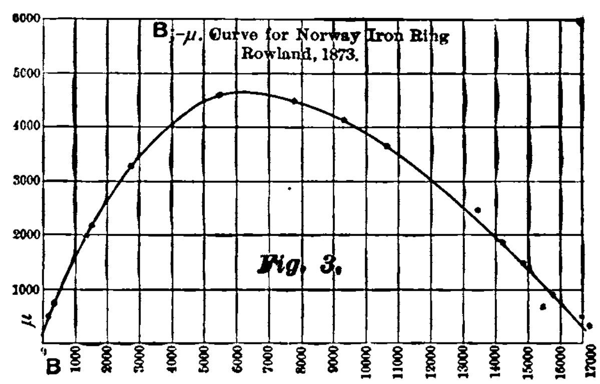


Fig. 3.

1. H—B or curves of magnetizing force and flux density.
2. H—μ or curves connecting permeability and magnetizing force.
3. B—μ or curves connecting flux density and permeability.

It is the object of this paper to show that there is a fourth relation that has not received the attention it seems to deserve—

1. Hopkinson. *Phil. Trans.* 1885, part ii, p. 462.
2. Rowland. *Phil. Mag.* 1873, p. 153, table v.

namely, the curves connecting the reluctance with the magnetizing force.

As an example of the comparative forms of these well-known curves, types 1, 2 and 3 are represented in Figs. 1, 2 and 3 for a sample of Norway iron whose results are among the first on record, being published in 1873.[2] The curve connecting the reluctivity with magnetizing force is shown in Fig. 4 and exhibits a greater degree of simplicity than any of the others. Curve 4 consists in fact of two lines that are very nearly straight, united

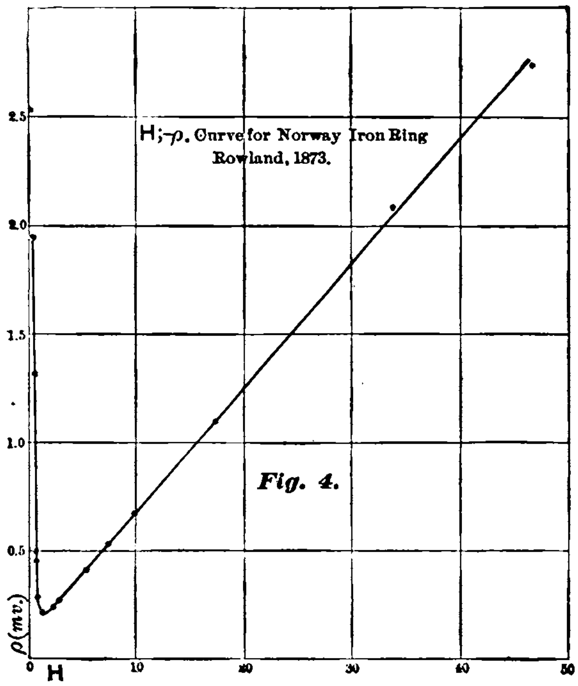


Fig. 4.

by a rounded elbow; and these outlines express the fact that the reluctance of this sample of iron was very nearly a linear function of the magnetizing stress brought to bear upon it. The ordinates for this curve are given in thousandths of an absolute reluctance unit, a quantity we may call provisionally a milli-unit abbreviated *MU.* The reluctance of 1,000 *M U.* in series would be that of one cubic centimetre of air. Reluctivity curves plotted from various sources all of which are duly given in the Appendix appear in Fig. 6 for various samples of iron and steel. The general type consists of two lines nearly straight, connected by an elbow which is sharper and more defined as the iron is softer and more nearly pure. With hard steel the change from the descending to the ascending line is very gradual. The reluctivity of iron appears from these curves to commence at a certain definite and moderately large value which we may denominate its initial reluctivity, descends very rapidly and nearly on a straight line to what may be called the critical reluctivity at the critical magnetizing force, turns abruptly, and then advances along a nearly straight line. Before the turning point in Fig. 4 the reluctivity may be expressed approximately by the equation $\rho = 2.9 - 3.5\,H$ while beyond the bend the equation becomes $\rho = 0.1 + 0.058\,H$. The flux density existing in this sample of Norway iron can be calculated by the Ohm's law formula for any value of H when the corresponding value of the reluctivity is taken from one or other of these two equations and the resulting curve of $B - H$ will practically coincide with that in Fig. 1 except in the immediate neighborhood of the critical value of H. This relation also exhibits the foundation that exists for the Frölich formula which has long been known to be practically valuable and even very accurate in application to dynamo-magnetic circuits, although both the method by which it was arrived at and the light in which it has since been regarded appear to have been empirical rather than fundamental.[1]

Fig. 5 shows that the minimum reluctivity for soft iron is about 0.15 *MU.* while its initial reluctivity is about 3.0 *MU.* The critical value of H is also in the neighborhood of 2. If any critical H can be said to exist for glass hard pianoforte wire it would be in the neighborhood of 35 units, and every description of hard or impure iron met with in practice not containing much manganese appears to have its critical H between these limits. These reluctivity curves also illustrate perhaps more clearly than any others the leading features of Ewing's theory of magnetization. There is first the initial stage of diminishing reluctivity during which the imaginary molecular magnets are being deflected from their original configurations, then a short critical range of magnetizing force in which nearly all the original groupings are disrupted at the point of lowest reluctance, and finally a steady increase of reluctance as the molecules are gradually forced by increasing magnetic stress into parallelism.

This bilinear characteristic curve of reluctivity is not confined only to iron. Fig. 6 shows the same general outlines in the case of nickel, taken from the observations of Rowland and Ewing. Here the initial reluctivities are higher, and the descent to the critical points much sharper than in iron, while the ascending lines are also steep but nearly straight.

Taking the equation $\rho = a + bH$ in the ascending curve, the first term a only disappears in one known instance—that of nickel under a mechanical stress of 19.8 kilograms per square millimetre or 28,160 lbs. per square inch—as seen in Fig. 7 taken from Ewing's results. The lowest ascending curve prolonged downwards almost meets the origin. Consequently the flux equation for such nickel would be

$$B = \frac{H}{bH} = \frac{1}{b} = \frac{1}{0.000177} = 5650$$

and this flux is practically constant for any magnetizing force within further considerable limits, representing early saturation. The influence of compression in diminishing the reluctance of nickel is clearly shown in Fig. 7. The critical reluctance is gradually diminished by the stress applied from 14.5 *MU.* at *H.* 30 to 2.6 *MU.* at *H* 12.

Fig. 8 gives the corresponding curves for cobalt. The same features are again observable. Only in one case, that of cast cobalt at 230° C., is there any considerable deviation from a straight line in either rise or descent from the critical segment of the curve, and this represents a series observed by Rowland under some experimental difficulties and alluded to as somewhat doubtful.

We have now examined the reluctance of the three magnetic metals collected from all the best-known experimental observations. In addition to these it appears that every reliable series of tabulated results for iron, pure, impure, cast or forged, exhibits the same types of bilinear reluctance referred to H between zero and 150, although in very hard or impure specimens there is no clear indication of a critical point. This assumes, however, that the observations are not vitiated by residual magnetism. For example, the curve obtained by plotting the reluctivities of cast iron as quoted by Silvanus Thompson from Hopkinson's observations[1] differ considerably from this type, but the difference appears to be accounted for by taking the mean between ascending and descending values. The ballistic method of measurement with anchor rings, in which the progress of the magnetizing force takes place by extending reversals, gives reluctances that appear to be as nearly linear as those which are obtained by a single increasing

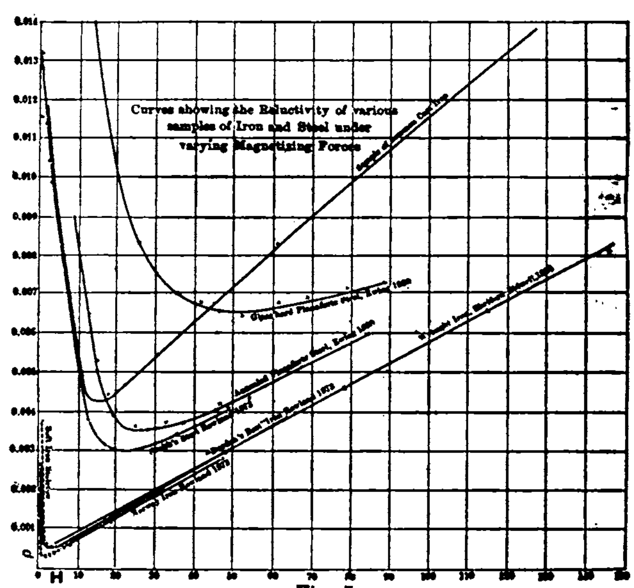


Fig. 5.

amplitude of magnetization, the influence of hysteresis being apparently nearly uniform in ratio.

An examination of reluctivity curves naturally suggests the question as to whether there is really a strict linear relationship between H and ρ. In other words, whether the divergences of the observation curves from geometrical straight lines can be fairly ascribed to errors of observation, allowing for the influences of residual magnetism.

1. Frölich. *Electrotechnische Zeitschrift.* pp. 90, 139, 1881, p. 73, 1882.
Silvanus Thompson. "Dynamo Electric Machinery." p. 305.
"Lecture on the Electromagnet." I. p. 74.
Ayrton & Perry. *Phil. Mag.* 1888, vol. xxv, p. 506.

1. Silvanus Thompson. "Dynamo Electric Machinery," p. 302.

First confining the inquiry to the ascending reluctivity line—that which is geometrically consequent upon Frölich's formula and also under special interpretation with Lamont's formula—the agreement of the plotted observations with a straight line between the neighborhood of the critical H and $H = 150$ is often so good as to intimate the existence of a definite linear relationship. It is generally to be found, however, that beyond 150 C. G. S. units of H, the line bends downward until all hope of rectilinearity is lost. That is on the simple circuit theory of reluctance. If, however, we introduce an amendment into the definition of reluctance borrowed from the vein or polar theory, the rectilinearity appears to be nearly sustained for a much greater distance. lines prolonged downwards nearly strike the origin. It is to be observed that at the limiting observation for wrought iron its reluctivity is nearly 20 per cent. greater than that of air or of the air-pump vacuum.

According to the simple circuit theory, the reluctance is of course the ratio of the magneto-motive force to the flux and the reluctivity this quantity locally reduced to the unit of volume. On the vein theory, however, which as we have seen distinguishes the vein flux from the magnetizing flux superposed thereon, the conductivity of a mass of iron is the conductivity of the iron itself added to that of the space it occupies, and consequently applying the vein theory to the magnetic circuit we have the

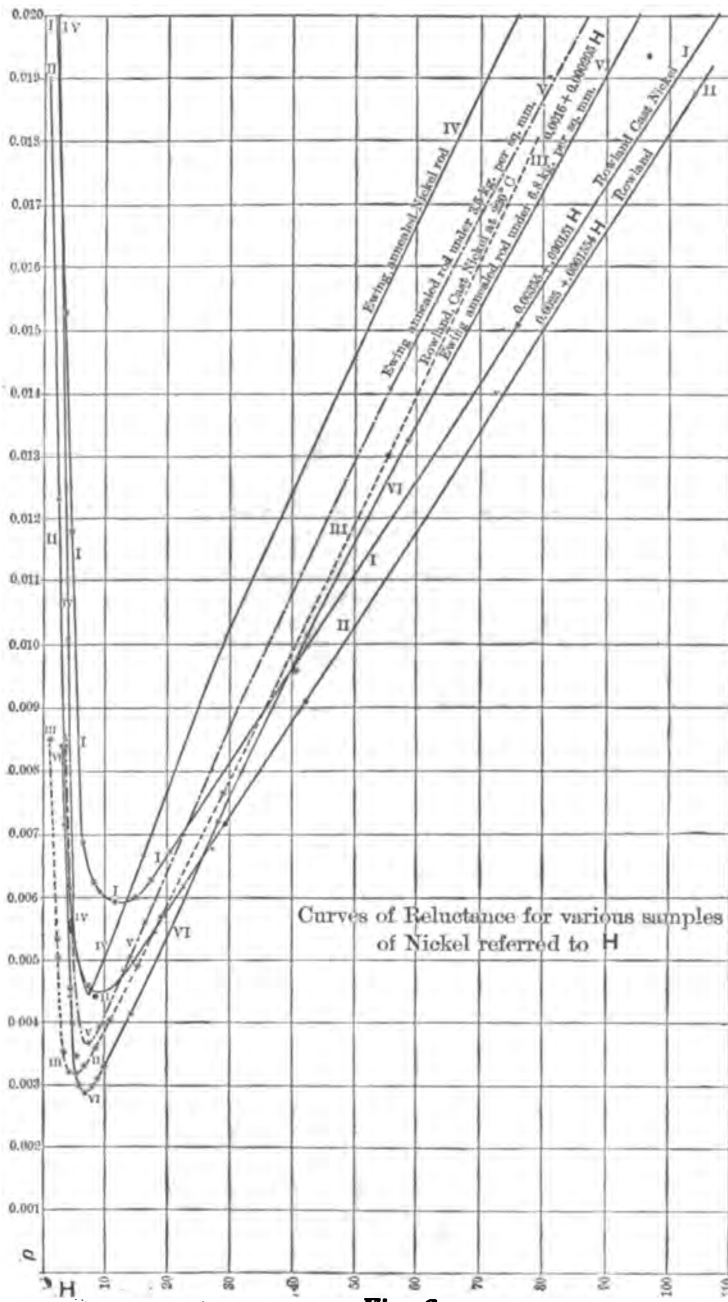


Fig. 6.

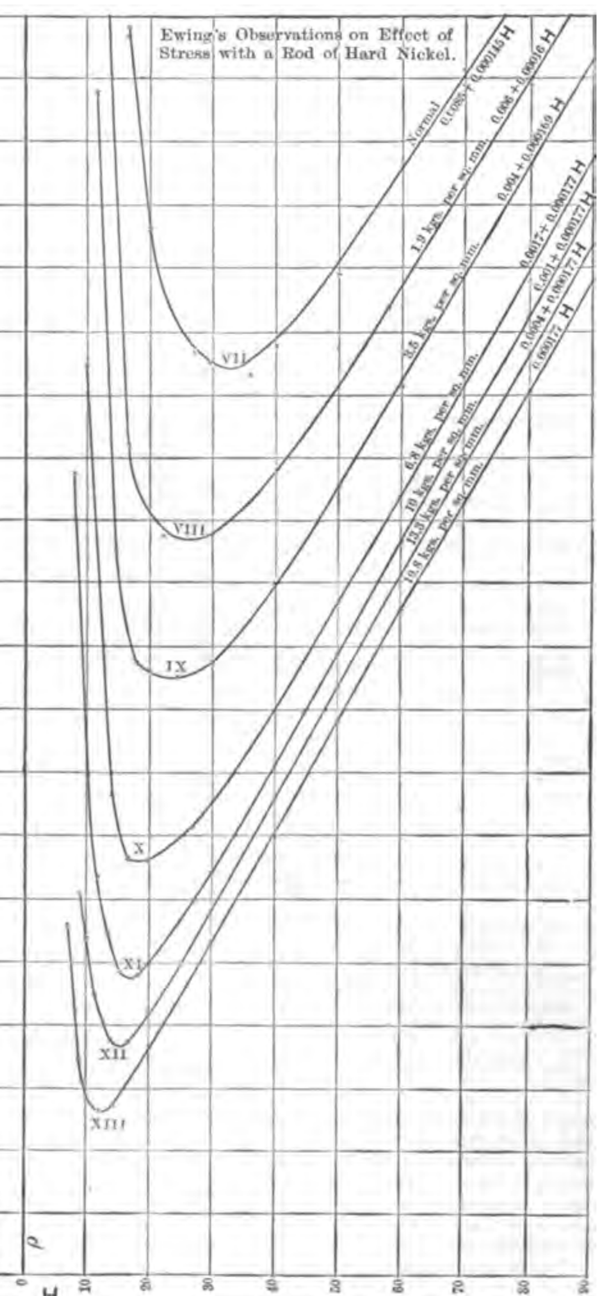


Fig. 7.

Experimental observations of the reluctances in circuits of the magnetic metals under powerful magneto-motive forces are yet very scanty, but judging from the results of Ewing and Low[1] the reluctivity of wrought and cast iron on the amended definition appears to be a linear or at least nearly linear function of the force as far as H 25,000 and H 11,000 respectively, the limits of the quoted measurements.

The graphs of these measurements are given in Fig. 10. The observations run from H 3.630 to 11,200 for wrought iron with an isolated observation at H 24,500 in a separate instance, the similar series for cast iron running from 3,900 to 10,610 units of H. The linear relationship is very fairly maintained and the apparent reluctance of the iron mass as the joint reluctance of two paths in multiple arc, one through the iron itself and what might be called its metallic reluctance, the other through the reluctance of the space occupied by the iron, and the removal of the iron would leave this latter unaltered. The difference between the apparent and metallic reluctance is inappreciable while the latter remains small, that is generally speaking when H is below 150, a limit rarely exceeded, and consequently the question does not present itself under practical conditions, but for large values of H, the difference is considerable and the metallic reluctance approaches the linear relationship with H while the apparent reluctance deviates considerably from it.

These assumptions from the vein theory while they may be

1. "*The Electrician*," London, 1890, July 25 and Aug. 1.

convenient are somewhat artificial for they postulate that the space reluctance of a given volume of air is not altered when the volume is occupied by iron. This may not be impossible but it is difficult to imagine any reluctance mechanism of ether that would remain undisturbed by the introduction of a massive substance. On the other hand while the vein theory imposes this principle not touched upon by the circuital hypothesis, it explains very satisfactorily the fact now apparently beyond dispute, that while iron can be saturated there is no limit yet attained to the flux density that can be made to pass through it. Ewing's results give no limit at the observed flux density of 45,350 C. G. S. nearly three times the flux density at which iron is commonly worked in practice, while at the same time they indicate a limiting value of magnetization long before that density is reached. Following the vein theory, the polarization of the iron is then complete and the intensity of magnetization or magnetic matter per unit cross-section of veins finds its maximum so that while the total flux can go on increasing indefinitely, it can only do so by adding to the permeating field flux, the vein flux having reached its full limit. It is not impossible to represent the observed condition of affairs by the simple circuit theory but the mental picture is not so clear. It would be possible for instance to imagine that the molecules of all substances transmitted the stress flux with the same or almost the same facility as the ether surrounding them, but that in the magnetic metals they exalted the stress in transmission. Maxwell supposed that the iron molecules were so constructed that they could take part in the ether spin that might constitute the stress, and if so by adding to it their momentum of revolution, they could augment its value. There would be then perhaps at a certain stress, a

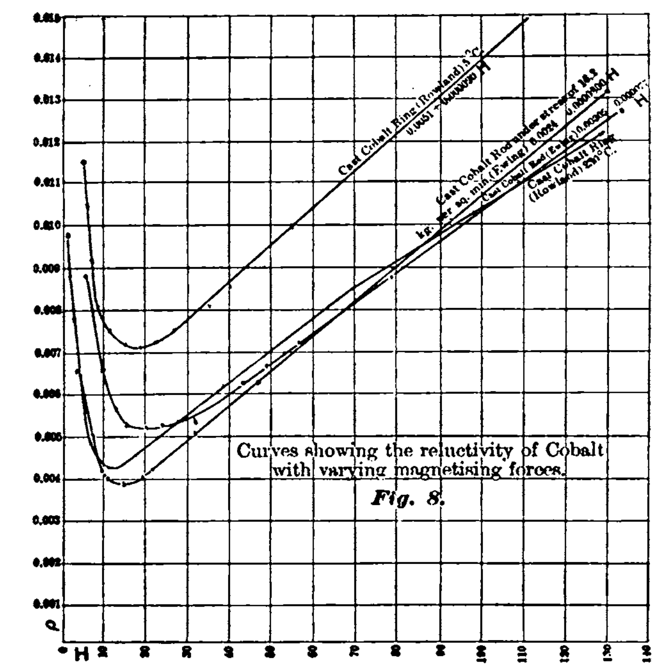


Fig. 8.

speed of revolution which the iron molecules would not exceed and their reinforcement would be at a maximum, while for stresses enormously greater than this the molecular augmentation would be lost in comparison with the strength of field and the iron molecules would in the aggregate behave almost like the motionless transmitters of other substances. The consequences of this conception seem more complex even if more nearly true.

Turning now to the descending curve of reluctivity between the initial and critical values, closer examination will show that here at least the linear relation is only an apparent one. The descent is so steep that on the scale of projection it appears nearly straight, but when magnified it has a distant curvature. Rayleigh[2] and others have shown that for small degrees of *H* the permeability commences with a definite steady value and this being the case it would be impossible for the reluctivity—the reciprocal of that permeability—to be linear towards *H*. Series of observations covering with sufficient detail the range of *H* from zero to unity are apparently few, and Fig. 9 gives the plotted values of the reluctivity on an enlarged scale observed by the writer for a sample ring of Norway iron. The descending line has a marked curvature approximately logarithmic, that would be almost inappreciable, however, on the scale of the other reluctivity diagrams.

Even, however, if we admit that there exists a linear relationship between H and ρ beyond the critical point, that is to say if the experimental results justify the belief that Frölich's formula is not merely an empirical one, we are scarcely entitled to attribute to this relationship an intrinsic physical signification. It may enable us to grasp the salient features of the magnetic circuit by the re-establishment of Ohm's law, but the relationship is more likely to be the consequence of a more remote fundamental

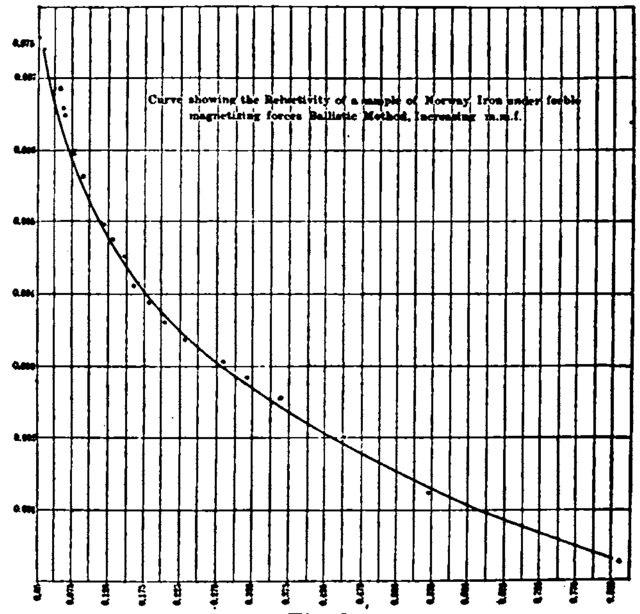


Fig. 9.

agency than to be significant of any physical condition resident in metallic reluctivity itself. This is for the reason that the increase of flux under M. M. F. in a magnetic circuit due to the presence of iron is more probably owing to an assisting M. M. F. set up in that iron under stress than to any change in the latter's reluctance, and the removal of the initial source of M. M F. from the circuit still leaves some M. M. F. active as residual magnetism.

The case is similar to that of an electric circuit containing a polarizing electrolyte. It might be more simple to ignore the counter E. M. F. of polarization and to regard the resulting diminution of current as the result of an extra resistance whose value might be tabulated or possibly even reduced to simple laws. So again in alternate current circuits it is often more convenient to speak of a resistance coil with inductance as possessing an impedance greater than its ohmic resistance and to determine the flow of current on the basis of impedance calculated to the original E. M. F. whereas the direct and fundamental method would be to keep the resistance at its true value and determine the current by allowing for the counter E. M. F. of inductance in quantity and in time.

Retaining then the latter analogy, we may say that flow in an electric circuit is subject to Ohm's law simply when the E. M. F. is constant, but when the effective E. M. F. varies periodically, the resistance has to be increased by a definite amount depending on the inductance and the manner of fluctuation in order to obtain the correct effective current under those conditions. Similarly

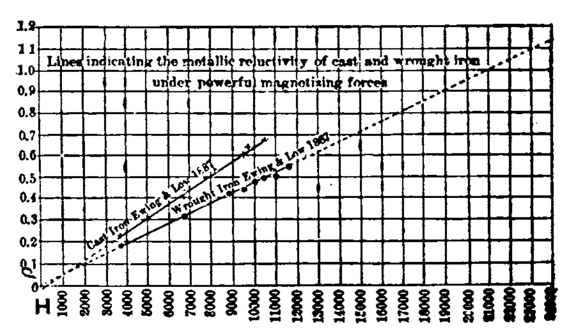


Fig. 10.

that the flux in a simple magnetic circuit of air or vacuum is subject to Ohm's law, but that if the circuit includes a magnetic metal, the reluctance in the formula has to be changed in a definite way depending on the quality of the metal and on the magnetizing force in order to obtain the corresponding true flux density. The change in reluctance is the ideal

2. *Phil. Mag.*, March, 1887.

connection of a shunt metallic circuit in parallel with the air circuit, and the reluctivity through the metal is nearly $a^1 - b^1\ H$ for values of H below the critical and $a + b\ H$ for values beyond, with a litttle uncertainty in the vicinity of the critical point itself.

ARTIFICIAL RAIN-MAKING AND ELECTRICITY.

In a lecture recently delivered before the Electrical Section of the Franklin Institute, Prof. Edwin J. Houston, after discussing the efficacy of various methods, and the causes tending to bring about the desired result, concluded as follows:

Since success in artificial rain-making is probably dependent on the meteorological conditions, both of the lower and upper layers of the atmosphere, efforts should be made to enlarge our present very limited knowledge of such conditions.

Captive balloons, containing registering electrometers, telethermometers, tele-hygrometers, tele-anemometers, etc., might be connected by wires with recording apparatus placed on the earth's surface. The cost of maintaining such aerial stations of observation would be but insignificant when compared with the benefit that would accrue not only toward the solution of the problem as to the probable success in rain-making, but the general operations of the United States Weather Bureau in particular, or of meteorology in general.

During the general prevalence of moist, warm air, when but a slight cooling is necessary to cause a general down-pour, effective rain-making might be obtained by the sudden breaking or opening of cylinders of liquefied gases, whose expansion would cause an intense chilling of the surrounding air; such cylinders could be readily opened by means of earth-controlled electromagnets.

The following general conclusions may, in view of the present state of meteorological science, be properly drawn concerning the artificial production of rain:

(1) That rain can never be made to fall at will by mid-air explosions on any part of the earth's surface, irrespective of the climatic conditions there existing.

(2) That during certain meteorological conditions mid-air explosions may result in rainfall over extended areas.

(3) That the liberation of energy necessary for such rainfalls is not due, except initially, to the mid-air explosions, but to the energy stored up in the moist air from which the rain is derived.

(4) That the meteorological conditions which must exist for the successful action of mid-air explosions would probably, in most, though not in all cases, themselves result in a natural production of rain.

(5) That a comparatively high difference of electric potential between different parts of the air or between the air and the earth, is possibly favorable when taken in connection with other meteorological conditions for artificial rain-making.

(6) That an undirected mid-air explosion is not as likely to produce rain as an explosion in which the main tendency of the energy liberated is to cause a general up-rush of the air.

A TECHNICAL REPORT ON "TANITE."

We give below a most striking report just made on tanite by Dr. Coleman Sellers, Prof. J. E. Denton, and A. R. Wolff. This report is entitled "The Comparative Value of Fifteen Varieties of Solid Emery Wheels," the investigation being made at the invitation of the Tanite Co., of Stroudsburg, Pa. The report is of a very interesting nature and runs as follows:

"At the suggestion of the Tanite Co. we associated ourselves in an inquiry as to the comparative value of the solid emery wheels. Our first object was to settle the question as to what constitutes a good, solid emery wheel; second, to establish test conditions of such scientific accuracy as to prevent any doubt of the results; third, to give thorough trial, under uniform test conditions, to the various wheels, and to secure a mass of exact data.

"Having determined on the qualities which constitute a good, solid emery wheel, we established our own conditions of test, and submitted to such conditions wheels of our own selection. The wheels of fifteen different mannfacturers were selected. These were: Celluloid, Crystal, Detroit, Grant, Hampden, Lehigh, Norton, Northampton, Norwich, Sterling, Tanite, Union Stone, Vitrified, Vulcanite, Waltham. Among these fifteen varieties only one compared favorably with the tanite wheel, the latter having easily beaten all competitors save one. The comparative values of the tanite and its one rival will have to be ascertained by further trials.

"It was unanimously agreed that hand testing must be done away with and the personal factor eliminated, in order that the results might be unimpeachable. The defect of existing test machines was speedily recognized, and it became necessary to invent a new testing machine. After much study and many trials your board, with the valuable assistance of Prof. Webb, of Stevens Institute of Technology, at Hoboken, constructed a machine which met the approval of all concerned. This machine was so constructed that the wheel and work were brought in contact by definite and measurable pressure without any obstacle being interposed to the free wear of either metal or wheel. The results approximated closely to those obtained by hand pressure, and yet were independent of all influence from the operators of the machine. The power consumed was measured by a dynamometer attached to the driving shaft, and the speed recorded by a tachometer. The resistance between wheel and metal was indicated continually by a standard scale.

"To constitute a good, solid emery wheel the following qualities should be combined: Safety under the widest conditions of use and misuse; rapidity of cut; freedom of cut at moderate pressure; reasonable amounts of wheel loss and power consumption; evenness of wear; general staying quality, and reliability under the widest range of circumstances. Our board had the test machine erected in the machine shop of the Stevens Institute of Technology, at Hoboken—and had the various wheels (bought directly by themselves) delivered at Stevens Institute. The grinding was done on cast-iron bars supplied directly to us by one founder. Special care being taken as to quality of metal and size of bar. The trials reported on were made at the Stevens Institute during 1889 and 1890, the tabulations being too voluminous to admit of detail here. During the latter part of this investigation the assistance of Prof. Jacobus (assistant professor of experimental mechanics at Stevens Institute) was secured.

"Our report is based on a long series of trials at three different pressures—42 lbs., 60 lbs. and 100 lbs. These separate trials numbered several thousand, during each of which exact data were recorded as to speed, power, resistance between the wheel and metal, amount of metal ground off, amount of wheel material consumed, and observations made as to the cleanness of cut, amount of heat generated, amount of glazing or clogging up of wheel with metal, and as to cracks, breaks and defects of wheels.

"Of the fifteen varieties six were found too unsafe to warrant their general use, 57 per cent. of the wheels bursting under the same conditions which other wheels passed through uninjured. Eleven varieties (among which are included the six unsafe varieties) were found to be such slow cutters that the average metal removal of ten of them was less than the general average of all the wheels. Of the fifteen varieties only four were found to be rapid cutters. Of these one wore so rapidly that the cost of its rapid cut was unreasonable. This left three safe, effective and satisfactory wheels, one of which, however, was demonstrated to work at a greater cost than the tanite. The rivalry was thus narrowed to two wheels, and, in the judgment of our board, further trials are necessary before the relative value of these two can be determined.

"One striking feature characterized these two. That is, that in every series of trials these wheels increased in productive capacity, the average of the last cuts of all the series being greater than the average of all the first cuts. The 13 other varieties of all decreased in productive capacity, the average of the last cuts being less than the average of the first. Some of these which made a brilliant show at the start, cut scarcely anything at the close.

"As nearly all the preliminary and collateral trials were made with tanite wheels, more than three times as many of these were used as of any other make. In all this use, under every degree of measured automatic pressure and under the heavy pressure of long bars used by hand (a test applied to no other wheel), and also at a speed nearly double that of any wheel save one, *not a single wheel burst.*"

The committee have in their possession an accumulation of data bearing on these tests.

Letters to the Editor.

THE EFFECT OF "NEWSPAPER INVENTIONS."

In the present depressed condition of the electrical trade, with investors hesitating about venturing in enterprises of any kind, it seems, to put it mildly, a little hard on the trade that the columns of the daily papers are being used to prematurely advertise alleged inventions, not yet invented, with a view of influencing the stock market for certain stocks, to the detriment of legitimate trade. The writer knows of several instances of street railways deferring change of motive power to electricity because these much-heralded inventions (?) are likely to revolutionize and cheapen the application of electric power. If such use of the daily papers is not intended for stock-jobbing purposes, it would seem a wiser and better course to wait until the details are completely worked out and then spring them on an admiring public. To any one at all familiar with the amount of business being done by the leading "parent companies," this particular use of the daily press savors of both stock-jobbing and dog-in-the-manger spirit.

TROLLEY.

NEW YORK CITY.

Reports of Companies.

ANNUAL REPORT OF THE W. U. TEL. CO.

THE annual meeting of the Western Union Company was held last month, and the old board was re-elected. The report for the year ended June 30 makes the following showing compared with the previous year:

Year, June 30,	1890-91.	1889-1990.	Decrease.
Gross rev............	$23,034,326	$22,387,028	*$ 647,296
Expenses............	16,428,741	15,074,303	*1'354,438
Net.	$6,695,584	$7,312,725	$707,151
Int. and s. f..........	931,219	915,135	*16,084
Balance..............	$5,674,365	$6,397,590	$723,225
Dividend............	4,309,607	4,956,008	646,401
Surplus......... ...	$1,364,758	$1,441,582	$76,824
Total surplus........	11,417,741	10,002,983	*1,364,728
Miles poles..........	187,981	183,917	*4,064
Miles wires..........	715,591	678,997	*36,594
Messages sent ......,	59,148,343	55,878,762	*3,269,581

*Increase.

The Western Union's report shows that the capital stock is unchanged, and the net bonded debt is $14,801,864, against $14,779,528 a year ago. The company charged to operating expenses $2,500,627 for maintenance and reconstruction of lines. The gross revenue from messages was $20,704,270, an increase of $1,240,622. The loss in revenue was from the falling off in commercial news service, rental of private wires, dividends from other companies and the rental of buildings. The increase in expenses was largely due to repairs after storms, repairs of both Atlantic and one Gulf cable, and the fire in the main building. The average tolls per message were 32.5 cents, against 32.4 last year. The average expense was 23.2 cents, against 22.7 last year. For the first time under the Gould management a balance sheet is printed. It shows a gross floating debt of $2,815,152, offset by $857,422 cash, and $2,129,852 accounts receivable. The cost of repairs, etc., on the Dey street building is, so far, $358,062; real estate is valued at $2,908,918, supplies $320,231, securities of leased telegraph companies $8,182,300, stocks of other companies $7,599,812. The plant, etc., is valued at $96,745,391. The total surplus has been expended upon the plant. The new miles of poles and cables added in the year were 3,964 miles, wire 36,594, and new offices 716. The uncapitalized surplus put into the property is $13,015,925. There is no important change in the securities of other companies in the treasury.

THE GREAT WESTERN ELECTRIC SUPPLY CO.

THE regular dividend, two per cent. in cash, amounting to $7,500, was paid October 10th on the $375,000 of the preferred stock of the Great Western Electric Supply Co. A dividend is also to be paid on the common stock of the company, if the business continues to prosper for the next two or three months as it has for the past three.

Society and Club Notes.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

AT the meeting of the council on Oct. 27, the following gentlemen were admitted to associate membership:

De Khotinsky, Capt. Achilles, electrician Germania Electric Co., Boston, Mass.
Dunston, Robert Edward, president the Connecticut Motor Co., Plantsville, Conn.
Middleton, Edward T., instructor in electricity and physics, Rutgers College, New Brunswick, N. J.
Monell, Joseph T., with F. B. Crocker, New York City.
Smith, T. Carpenter, partner in firm of M. R. Muckle, Jr., & Co., Philadelphia, Pa.
Strong, Frederick G., electrician Midland Electric Co., Denver, Col.

The following were transferred from associate to full membership:

Eustis, Herbert H., president and electrician Eastern Cable Co., Boston, Mass.
Paine, F. B. H., consulting electrical engineer Chas. Paine & Sons., New York City.
Curtiss, George F., electrician Thomson-Houston Electric Co., Lynn, Mass.
Boynton, Edward C., Elektron Manufacturing Co., Springfield, Mass.
Weller, H. W., R. R. inspector Edison General Electric Co., New York City.
Delany, P. B., inventor, South Orange, N. J.

A meeting of the Institute Committee on the International Electrical Congress of 1893 was held in the office of the secretary, 12 West Thirty-first street, New York City, October 27th. The committee is composed of the following members: Edward Weston, Dr. S. S. Wheeler, Geo. A. Hamilton, Prof. Henry Morton, Prof. Chas. R. Cross, C. H. Haskins, R. W. Pope, Prof. W. A. Anthony F. L. Pope, Prof. E. J. Houston, T. C. Martin, T. D. Lockwood, G. M. Phelps, C. O. Mailloux and Carl Hering. The committee organized permanently, and elected T. C. Martin, chairman, and R. W. Pope, secretary. It was voted that the members of the existing Committee on Units and Standards be added to the Congress Committee, also the following members: Prof. Elihu Thomson, Prof. Alexander Graham Bell, Dr. E. L. Nichols, Mr. Nikola Tesla and Mr. Ludwig Gutmann. A subcommittee of three was appointed by the Chair, composed of Messrs. Carl Hering, W. A. Anthony and A. E. Kennelly, to formulate a provisional programme for the work of the Congress. The chairman is a member ex-officio of this committee. It was recommended that the Council appoint a committee to be sent to Chicago as soon as possible, to represent the claims of the Institute to a leading part in the Congress and to arrange for its co-operation with the authorities there upon a proper basis. The Council subsequently appointed Prof. Elihu Thomson, Mr. C. H. Haskins and Mr. F. L. Pope as such committee.

A "WURZBURGER NACHT" AT THE ELECTRIC CLUB.

UNDER the title of a "Wurzburger Nacht," an entertainment was given at the New York Electric Club last Thursday that proved an immense success, not only in point of attendance, but in the real enjoyment derived by everybody from the affair. The name was a suggestion from Mr. P. H. Alexander, the chairman of the House Committee, and the execution was due to Secretary S. L. Coles. The parlors of the club were laid out in smoking concert style; a German flag was festooned around the mirrors, and to make it feel at home a keg of Wurzburger bier and a white-aproned Gambrinus were installed opposite to it at the other end of the room. The proceedings were veiled under a mist created by 150 yards of clay pipe, but when the clouds of smoke had rolled by it was seen that nothing had happened that could bring a blush even to the sensitive maiden cheek of the *Mail and Express*. During the evening a number of pieces were sung by the Gilbert Quartette, composed of C. D. Mead, first tenor; A. C. Plant, second tenor; E. Hammann, first base, and Eugene A. Demonet, second base. Mr. Caldwell, a guest of the club, and a member of the Miss Helyett Co., favored the club with several fine songs, and Mr. Prine, the well-known New York tenor, also contributed. Piano selections were given by Dr. Wangemann, Messrs. Guy, Maguire and Colvin, and recitations by Messrs. H. M. Peckham, Issertel and Muldaur. The evening went off so well that the Entertainment Committee has already been asked by several members to arrange for another "relaxation under a pseudonym," and proposes to do so on either the last night of 1891 or the first night of 1892, when the club silver punch-bowl is brought out.

NEW YORK ELECTRICAL SOCIETY.

THE New York Electrical Society inaugurated the series of lectures, which it has arranged for the season of 1891-2, on the evening of the 22d inst., when Dr. Schuyler S. Wheeler gave some valuable data on the "Management of the Electric Motor." The lecture was fully illustrated by drawings and experiments, and the audience were able to see in actual operation many of the distinctive characteristics of various kinds of motors. Such lectures as these are calculated to do an immense amount of good, combining as they do the enunciations of principles and their practical exemplification. The society is to be congratulated on its new departure, and the excellence of Dr. Wheeler's lecture augurs well for the rest of the series.

WIREMEN AND LINEMEN'S UNION.

A SPECIAL dispatch from St. Louis says: Henry Miller, formerly President of the Wiremen and Linemen's Union, of St. Louis, has returned from an extended trip, during which time he organized unions in Louisville, Ky.; Omaha, Neb.; Minneapolis, St. Paul, Duluth, Milwaukee, Chicago, Toledo, Cincinnati and Indianapolis. These unions will send delegates to attend a national convention in St. Louis, Nov. 21. The electric wiremen are now affilated as locals with the American Federation of Labor. Unions with a membership of 25 will be entitled to one delegate, unions having 50 members to two delegates, unions having 100 members to three delegates, and each additional 100 members or fraction thereof not below 50 one more delegate. The organizing committee of the Electric Wiremen and Linemen's Union, of St. Louis, will hold a special meeting for the purpose of making arrangements for the convention. About 28 unions are now organized in the United States.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

AT the last meeting of the Executive Committee of the National Electric Light Association a very complimentary and deserved resolution was unanimously passed, thanking Mr. John Carroll, of the Eugene F. Phillips Electrical Works, of Montreal, Canada, for his untiring and eminently successful labors in connection with the reception of the Association during its Convention at Montreal. These resolutions were ordered engrossed and presented to the above-mentioned gentleman. Every visitor to Montreal at the Convention will add his endorsement to this resolution. Mr. Carroll was simply indefatigable, and much of the great success of the occasion was due to him.

ELECTRICAL SECTION OF THE FRANKLIN INSTITUTE

AT the stated meeting held Tuesday Sept. 8, 1891, Prof. Edwin J. Houston read a paper on "The Artificial Production of Rain." There was much discussion on this subject, and also on the queries from the question box regarding the comparative intensity of the magnetic north and south poles of the earth, and the results obtainable in using Edelmann's electrometer as described in Ayrton's *Practical Electricity*.

Legal Notes.

INTERFERENCE: STANLEY AND EDISON—HAIR FILAMENTS.

A PATENT was issued on December 12, 1882, to William Stanley, Jr., for an incandescent lamp burner of carbonized hair, and a process of making the same. Thomas A. Edison filed an application for a patent, with broader claims, including, however, the subject-matter of Stanley's claims, on January 4, 1884. An interference was in due course declared by the Patent Office. Counsel for Edison then moved for a dissolution of the interference, on the ground that no interference in fact existed, in view of the prior state of the art as set forth in certain British patents. Commissioner Simonds decided on October 3, that in a case where an applicant has claimed a genus, and a patentee a species, clearly coming within such genus, and when the interfering applicant has recited the same species as being within the genus, there must be an interference in fact, and that therefore the interference could not be dissolved.

WESTINGHOUSE CO. vs. EDISON CO.—ENCLOSING STREET RAILWAY CAR GEARS.

THE Westinghouse Electric & Manufacturing Co. has commenced a suit against the Pittsburgh & Birmingham Traction Co., operating under the Edison system, alleging infringment of letters patent No. 442,459, of December 9, 1890, granted to the Westinghouse Co. as assignee of Albert Schmid, for an enclosing case for enclosing the gears of a street-car motor to suppress noise, and at the same time provide for automatic lubrication.

Patent Notes.

A DECISION AGAINST THE DRAWBAUGH TELEPHONE CLAIMS.

THE Drawbaugh telephone case, which has been dragging through the Patent Office for the last eleven years, was decided on October 28 by Commissioner Simonds's affirmation of the decision of the Board of Examiners-in-Chief, denying the patentability of the subject-matter of an application for patent for telephones, filed by Daniel Drawbaugh on April 3, 1884, in continuance of his original application filed July 26, 1880. The decision is on the ground that the invention was put to public use by Thomas A. Edison and others for more than two years prior to the date last mentioned, the evidence being presented that Edison had made the complete invention as early as July 30, 1877, as disclosed in the shape of his British patent of that date, etc.

College Notes.

KANSAS STATE UNIVERSITY.

AT the last meeting of the Topeka, Kan., local committee on university extension education, final arrangements were made for the lectures on electricity and magnetism by Prof. Blake, of the Kansas State University, to be delivered with suitable experiments conducted with the help of a skilled assistant and all necessary apparatus, in the high school rooms, Topeka, on Friday, the 23d of October, between the hours of 8 and 10 P. M., and every fourteen days thereafter, at the same time and place.

Personal.

MR. A. F. MADDEN.

MR. A. F. MADDEN, the well-known electrical engineer and inventor, appeared in New York last week for the first time in four weeks. A month ago he had about one chance in a thousand of retaining his sight, and when it is said that to-day both of his eyes are as sound as they ever were, it is unnecessary to add that he is happy and also full of gratitude to Dr. Charles I. Kipp, to whose skill he is indebted for his escape from blindness. A month ago he was superintending some work in the shop of Lloyd & Paxton when a chisel in the hand of a workman broke, and a fragment of the steel struck Mr. Madden in the right eye. It was an inch long, one-quarter of an inch wide and one-eighth of an inch thick, with jagged edges. It partly embedded itself in the eyeball, splitting it from the iris to the muscle in the corner of the eye. It was so firmly fixed that Mr. Madden had to exert considerable strength to remove it.

He jumped into a cab and was soon in Dr. Kipp's office. The latter introduced cocaine into the eye, thus stopping all pain, and then sewed up the ugly seam which the steel had made. Thereafter a professional nurse attended Mr. Madden at his home in a dark room, and applied compresses of ice every two minutes to keep down the inflammation, which, had it prevailed, would probably have involved both eyes and destroyed them. Fortunately the steel was a fresh piece, which had not oxidized and had no poison on it. Nevertheless, Mr. Madden rightly regards his recovery as remarkable, and gives praise to Dr. Kipp for performing with success a wonderful operation. Dr. Kipp's own opinion of the case may be inferred from the fact that at the outset he gave Mr. Madden very little hope of saving his sight.

For some little time Mr. Madden will wear smoked glasses. The injured eye betrays little sign of the great peril and severe ordeal it has been through.

MR. LAURENCE J. WEBSTER, of the Massachusetts Electrical Engineering Company, sailed on the S. S. "Umbria" recently on a business trip of several months in England and Germany.

Appointments, Etc.

MR. L. A. SHERMAN, manager of the Port Huron, Mich., telephone exchange, will shortly relinquish his position.

MR. J. P. GRIFFIN has become associated with the Eastern District of the Edison General Electric Co.

PLOUGHING WITH DYNAMITE.

SUB-SOIL ploughing with dynamite fired electrically is one of the new methods in the South, and it is said to be equal to the process of trenching used by market gardners to loosen the earth to a depth of two or three feet, and allow the absorption of a good deal of water for sustaining vegetation during a drought. The inventor drills holes two or three feet deep and five feet apart, making 1,600 to the acre. In each he puts an explosive, and, after tramping, discharges it, the whole nmber being connected with a wire leading to a battery. In a recent experiment the explosive used was one-fourth of a small-sized dynamite cartridge, with about an ounce of Judson powder. The surface of the ground appeared to be lifted two or three feet, a few small clods being thrown up to the height of a house. It was broken to the depth of 30 inches at the points of the explosion and sidewise for a part of the distance between the holes.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Advertising is a common sense way of getting business.

THE HALL SAFETY ELECTRIC CUT-OFF.

THE safety electric cut-off, shown in the accompanying illustrations, Figs. 1 and 2, consists of an electromagnet, conveying the current from a dynamo into two contact levers, through which a working current passes, and is so arranged that when the current fails the united levers fall apart, breaking the line in two places instantly. It frequently happens that the current, although not totally failing, is partially interrupted, producing flashing of the lights, or unevenness of current employed for motors. While this cut-off is very sensitive in movement, it is so constructed that it prevents the opening of the line unnecessarily in such instances. It will be seen that the cross bar which connects the levers near their free ends is also connected by a link to a piston rod of a dash-pot, the upper end of the link being pivoted to a bracket secured on a cross-bar, and the lower end of the link being pivoted between ears. The lower end of the piston rod is fitted with a plunger working in a dash-pot, partly filled with glycerine, which slightly retards the movement of the falling lever when the circuit is broken. The use of the dash-pot allows the current to circulate about one second, which enables the electromagnet to restore the lever to its proper position if the current be immediately re-established in full force.

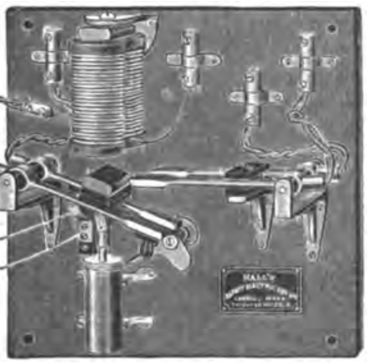


Fig. 1.

The object of this cut-off is to guard against accidents from broken wires.

An alarm device consisting of a small buzzer or bell is arranged in a short line containing a battery and a spring switch. The terminals are normally held apart by their own elasticity, and are brought in contact by an arm connected with the lever of the main switch over the dash-pot, which falls downward when the main line becomes broken.

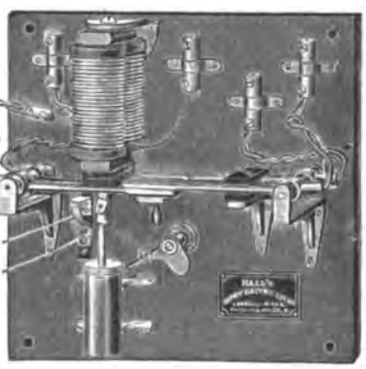


Fig. 2.

This invention is said to work perfectly under all conditions. It was invented by Mr. George L. Hall, an electrician of Lowell, Mass., and is patented in the United States and foreign countries. A company is being formed to manufacture and introduce this cut-off, and it is now in the hands of the Patent Electric Cut-Off Co., Box 599, Lowell, Mass.

THE RAE CAR IN PITTSBURGH.

DURING the recent convention in Pittsburgh an inspection trip was made over the lines of the Duquesne Traction Co. by the car just put on the road by the Detroit Electrical Works. Everything worked very nicely, and the only disappointment was due to the fact that full speed could not be made owing to the presence of a car of another make on the same track, just ahead. The Rae car beat the record, however, by climbing the steepest grade in 2 min. 40 sec. as against 3 min., the previous best time. This was done with 28 people on the car. In view of the assertion sometimes made that the Detroit Works cars do not take kindly to sharp curves, it was worthy of note that with a 6 ft. 6 in. wheel base truck, this car went around a 27 ft. radius curve with as little apparent effort as if it had been a 40 ft. curve.

PERRET MOTORS FOR CHURCH ORGANS.

THE following letter bears eloquent witness to the successful use of electric motors for organ blowing:

READING, PA., Oct. 24th, '91.

THE ELEKTRON MFG. CO.,

GENTLEMEN: Find enclosed check in payment for motor furnished us. The motor is giving perfect satisfaction to ourselves, the church and the organ builders—such satisfaction that the organ builders have resolved to use the Perret motor exclusively for blowing organs wherever possible to do so.

Respectfully,

PRINTZ & HILL.

SHORT ELECTRIC RAILWAY CO.

THE Short Co. have taken a contract for the equipment of the Trenton, N. J., Passenger Railway Co.'s road. The first delivery of apparatus will comprise 15 motor cars and three generators, to be followed by five motors and an additional generator. The first part of the plant will be put in early next spring, and a very large portion of the line will probably be equipped by next fall. The motors will be single reduction of the latest type, and the generators will be of the new design.

THE MICHAELIS COAL MINING MACHINE.

Electric coal mining machines have now been introduced in the Monongahela coal fields for nearly two years, and since then their adoption has rapidly increased. One of the latest mines to be operated by these machines is the O'Niel & Peterson mine, at Bunola, on the Pittsburgh and Belle Vernon Railroad, on the Monongahela river. The contract for equipping the Bunola mine was made with the Michaelis Electric Coal Mining Machine Company, of Pittsburgh. The plant consists of one 50 h. p. steam engine, one 30 h. p. Westinghouse alternating current generator and eight mining machines with the Tesla motor of the Westinghouse Electric and Manufacturing Co. attached to each machine.

The Michaelis coal mining machine has long passed the experimental stage; it has in fact been in practical successful operation for 15 months. The capacity of each machine per day is 65 tons of coal, or about one square foot of undercut per minute for ten hours each day. The machine requires very little attention, only one man being necessary to attend to it.

W. H. GORDON & CO.

W. H. GORDON & Co, 115 Broadway, New York, have taken the selling agency for Bryant's sockets, switches, cut-outs and specialties, Sunbeam incandescent lamps, Fletcher's specialties, as well as electric railway line material. They desire to call the attention of central stations and isolated plants to the fact that they are "headquarters" for all these goods, and that they are now carrying quantities in stock, so that orders can be filled promptly and satisfactorily. The reputation of this house for prompt shipments has become proverbial, while, as Mr. Gordon expresses it, "We are keeping in step with the decline in prices, and believe, considering the quality of goods we recommend, they are the cheapest in the market. We want to win the reputation of selling the best goods at reasonable prices, so that a company wanting something good and reliable will naturally think of coming to us for it." This would appear to be the right policy for a firm who are in the trade to stay.

ELECTRIC HOISTS.

THE Pleasant Valley Coal Company, of Salt Lake City, Utah, have for the past year at the Castle Gate Mine, in Utah, used a hoist or haulage drum operated by electricity. The drum was made by the Lidgerwood Manufacturing Company, of New York, and the electric motor and the electrical equipment furnished by the Thomson-Van Depoele Electric Mining Co., of 620 Atlantic avenue, Boston, Mass., together with all the electrical apparatus for the power station.

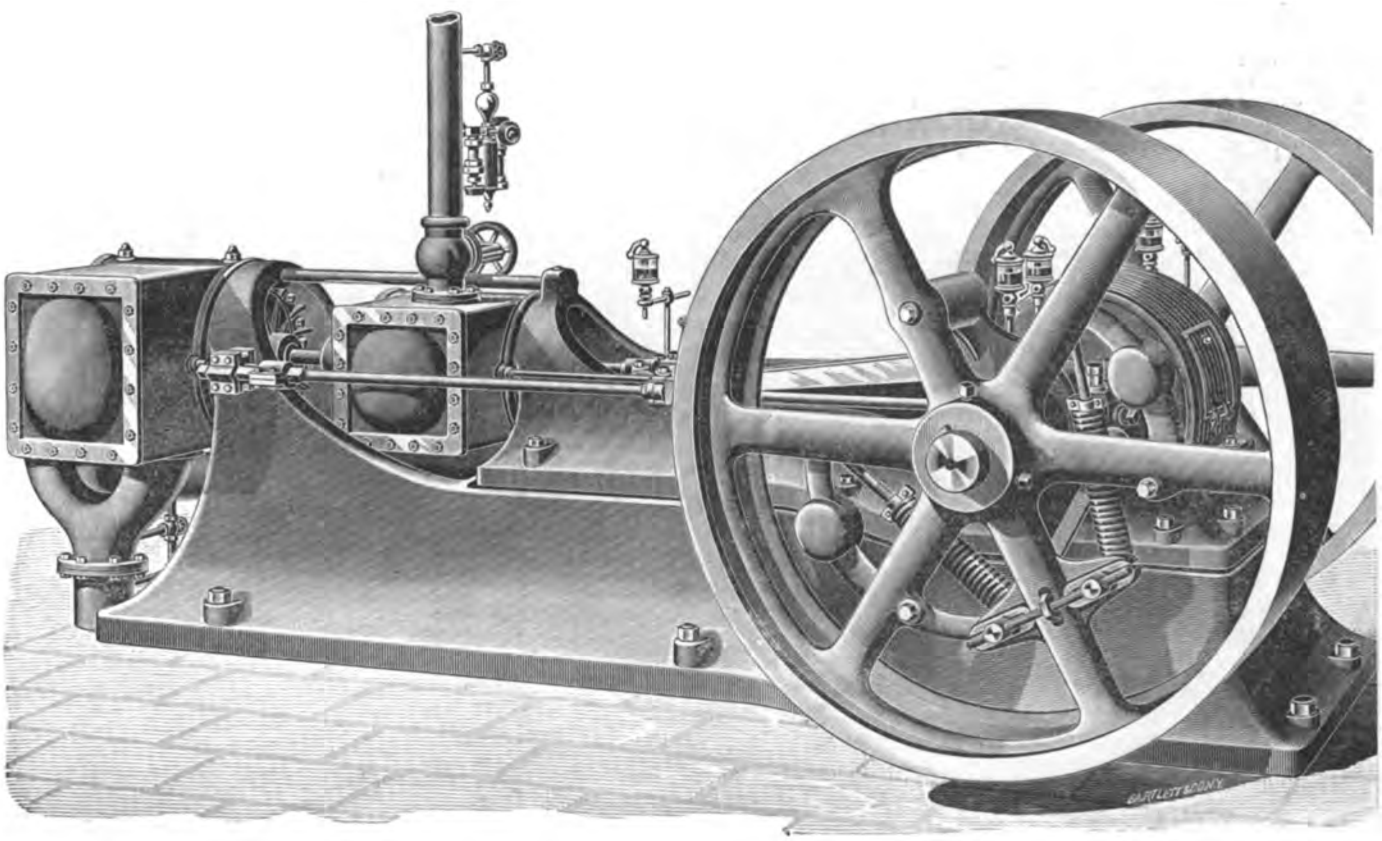
Trains of sixteen large pit cars run out of the mine by gravity, dragging the tail rope after them. The empty trains are hauled back into the mine by the haulage drum, located nearly 2,000 feet from the chute in the interior of the mine. The operation of this apparatus has proved so satisfactory and so economical that the company have ordered two more electric hoists of more powerful type.

In every way the electrical apparatus has been satisfactory to the company—so much so that for the Winter Quarters Mine, operated by the same company, they have ordered an electric locomotive and the equipment of nearly two miles of underground railway with the Thomson-Van Depoele system.

THE WESTON COMPOUND ENGINE.

THE accompanying illustration shows the Weston compound engine, built by the Weston Engine Co., Painted Post, N. Y., and handled in New York City by Julian Scholl & Co., 40 Cortlandt street.

As will be seen, the sub-base is made a part of the engine proper by extending it and projecting a neck in front of the high-pressure cylinder for the attachment of the large or low-pressure cylinder. This arrangement has several advantages, principal among which is the accessibility of the low-pressure cylinder for inspection. As leakage from this cylinder represents the most serious loss, it is obvious that the usual practice in tandem compounding of making the low-pressure cylinder practically inaccessible is a mistake, as, if no opportunity is given for examination of the piston, the loss from this item may be enormous. Another advantage of this form is the total elimination of cylinder vibration, securing great rigidity and permanent alignment. These engines have a balanced four-admission valve on each cylinder, and both valves are attached in a direct manner without rocker arms to an automatic governor, thus keeping the load about evenly divided between the two cylinders. This is claimed to have decided advantages over the usual arrangement of having a low-pressure eccentric fixed to the shaft or adjustable by hand. As the actual load is frequently considerably below the maximum in practice, the vital feature of compounding is destroyed; whereas, with the automatic attachment to each valve, the engine is always in condition to take care of any load within the range of its capacity and without disturbing any of the essential elements of compounding. This feature of two automatic valves will doubtless be well received, and where strict economy of fuel is necessary its advantages are obvious.



WESTON COMPOUND ENGINE.

THE GREAT WESTERN ELECTRIC SUPPLY CO. are having splendid success with their Sun arc lamp, which is manufactured by the Sun Arc Lamp Co., of Chicago. They have installed a number of Series sets in various railroads throughout the West, and in every case the lamps are giving most excellent satisfaction. They operate either 5, 6 or 7 in series, on a 500 volt railroad circuit. These give a beautiful white light, without flickering, and are made in from 1,200 to 2,000 candle power each. For lighting car barns and power houses, as well as street crossings and areas through which railroads pass, they cannot be excelled. The Great Western Co. have just completed the delivery of the steel poles for the Citizens' Street Railway Co., Indianapolis, Ind., the contract for which they were awarded a few months ago. The Citizens' Street Railway Co. express great satisfaction with their poles, and consider them an ornament to the streets through which the lines pass.

POOR ELECTRIC LIGHTING AT COHOES, N. Y.

A TRUSTWORTHY correspondent writes us: "The electric lighting system in Cohoes, N. Y., is a cause of widespread dissatisfaction to many of the heaviest taxpayers. The cost to the city per lamp or candle power could not be ascertained at the time of a recent visit, and data promised has not come to hand, but your correspondent was shown several street lamps which appeared as though formerly used for gasoline and which had not been cleaned for some months. Inside the square lantern a single incandescent lamp had been placed, and when lighted, the glimmer of the lamp through the dust and cobwebs of an age unknown hardly gave a favorable comparison with the kerosene street lamp of years past. The arc lights at the intersections of the main streets were but fair, and the area of light was quite circumscribed in extent. It would appear that the management of the electric light station in this city would bear a lively overhauling, and that unless it is done at once, and a daily supervision of each and every light inaugurated, an investigation will be set on foot to either know why the service cannot be improved, or else compel a return to the ancient order of lighting.

"The gas furnished in the stores and factories is of good quality and illumination, and although several of the factories have recently placed private plants for electric lights in their workrooms, yet the public streets are not as fully illuminated as they should be with the power expended; neither has the electric lighting company been very successful in displacing gas in the stores."

THE JOSEPH DIXON CRUCIBLE CO.

THIS company have for a number of years been preparing, at their factory at Jersey City, N. J., graphite mixtures for lubrication, which have found great favor with machinists and steamfitters throughout the country. Their graphite pipe-joint mixture is claimed to be infinitely superior to anything else for the same purpose, while their graphited oil is used for lubricating bearings.

The *Moniteur Industrielle* recommends the use of a mixture of oil and graphite on all screws in machinery. It says it will effectually prevent them from becoming fixed, and protects them for years from rust while at the same time the mixture facilitates tightening up.

THE ALUMINIUM CARBON CO.

MR. FRED V. DOTY, the general manager of the Aluminium Carbon Co., of Buffalo, N. Y., writes us that, although the capacity of their factory is 60,000 a day, they are now running night and day to keep up with orders. "Our carbons have proved all that we have claimed for them. That is, they are more than 25 per cent. longer lived, and are of lower-resistance than any others on the market."

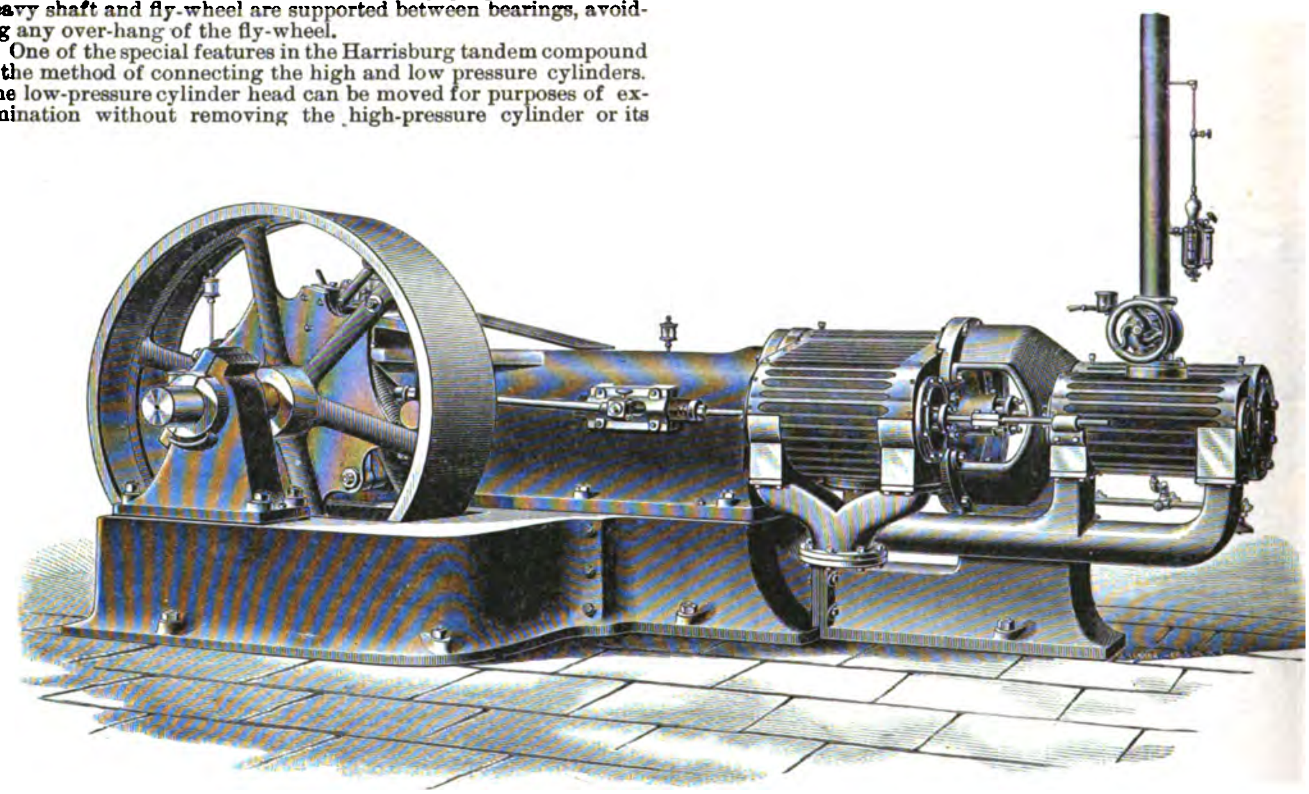
THE HARRISBURG TANDEM COMPOUND ENGINE.

THE Ide tandem compound engine, as manufactured by the Harrisburg Foundry and Machine Works, and represented in the accompanying illustration, is substantial and compact in design, neat and attractive in appearance, and is made exceptionally large in all bearings and journals, with a view of comfortably transmitting the maximum power, when run condensing.

It is well adapted for the transmission of power for electric railway lighting or factory use, being designed for working at high relative speed for direct belting if desired, with the extraordinarily close regulation for which the simple Ide engine is remarkable. When used for electric railway purposes the extra heavy shaft and fly-wheel are supported between bearings, avoiding any over-hang of the fly-wheel.

One of the special features in the Harrisburg tandem compound is the method of connecting the high and low pressure cylinders. The low-pressure cylinder head can be moved for purposes of examination without removing the high-pressure cylinder or its steam and exhaust connections. The inablity to do this has been one of the greatest objections to the tandem compound engines as usually built. The manner of supporting the high-pressure cylinder is very substantial, avoiding the vibration of cylinders when working under full load. The advantages obtained in making this connection between cylinders has been regarded so important that a patent has been applied for.

The Harrisburg Foundry and Machine Works are represented in New York, Boston and Philadelphia, and other cities through their regular agencies.



HARRISBURG TANDEM COMPOUND ENGINE.

THE RIES ETECTRIC SPECIALTY COMPANY.

THE Ries Electric Specialty Company, of Baltimore, are meeting with an unprecedented demand for their regulating sockets which they exhibited at the Montreal Convention. A combination of skillful advertising, hustle and general merit is bringing in orders for these sockets beyond even their most sanguine expectation. The last addition to their circular matter is a handsome four page folder, showing a cut of their socket and giving eight common sense points regarding the desirability of its use under different conditions. Those unfamiliar with the device should apply for a copy of this circular at once.

RESTAURANTS IN THE ELECTRICITY BUILDING, WORLD'S FAIR.

ALL of the restaurants in the Mines and Mining and Electricity Buildings will be in the galleries. This was determined in order to leave the ground floor free as far as may be for intending exhibitors. It is thought also that restaurants on the second floors of the buildings would prove an attractive feature. It was also decided that the restaurants in the Electricity Building be located in the two bays at the north end of the hall. In each bay there is to be one large dining-room, surrounded by several smaller rooms twenty-three feet square. The balcony connecting the two is to be fitted up for serving temperance drinks and ices. In the great Manufacturers Building about 40,000 square feet have been set apart for restaurants.

A CONVENIENT SOLDERING FLUX.

No one who has had the care of a central station can fail to recall the numerous "faults" which developed on account of bad joints. It is not always possible to use continuous lengths of wire, but no splice should be left unsoldered. Soldering with acid being a disagreeable and slow task, we are glad to call attention to a convenient article in the form of a soldering salt put up in bottles by the Electrical Supply Co., of Chicago. This only needs the addition of water to make it ready for use. It is claimed that there are no unhealthy fumes, and that it will not corrode the wire.

TRIUMPH COMPOUND ENGINE CO.

THE new machines for setting type, lately introduced by the Commercial Gazette Company, are operated by one of the engines built by the Triumph Compound Engine Company, of 211-217 West Second street, Cincinnati. Situated in the fifth floor of this building, the engine is a marvel—noiseless, producing no tremor, and doing its work perfectly. It is especially desirable for driving high-speed machinery, where close regulation is necessary, and economy of space important.

THE GLOBE CARBON CO.

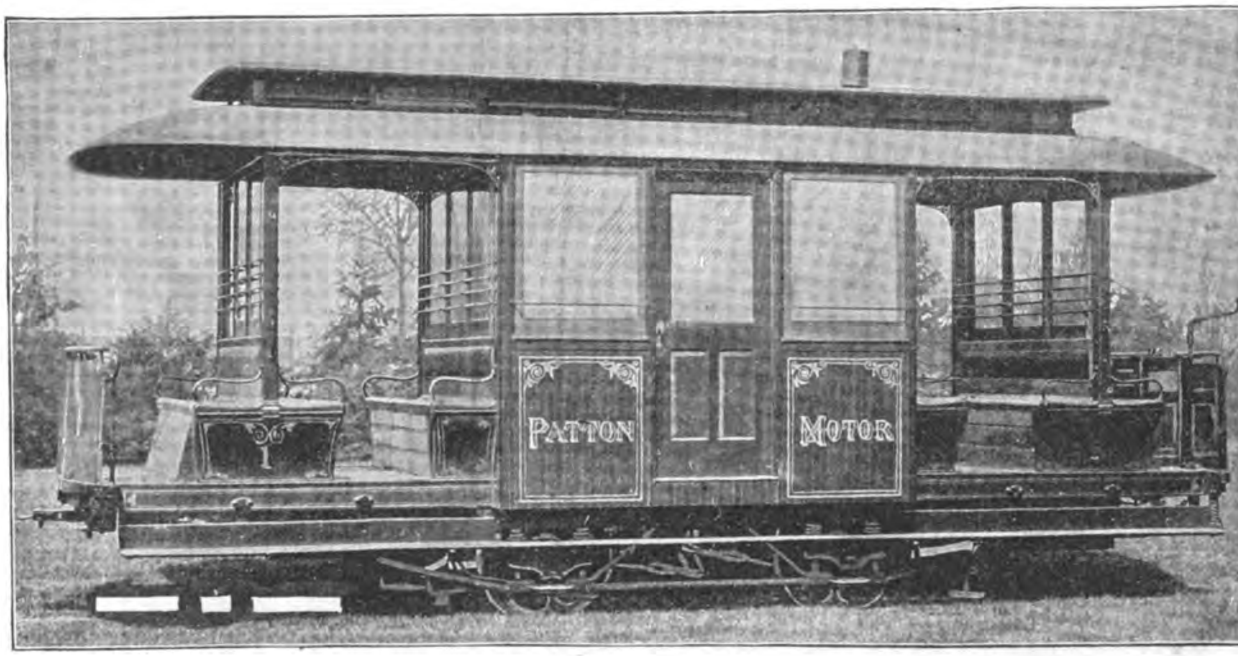
THE above company have recently removed their works to Ravenna, Ohio, where they will have a capacity of 100,000 finished carbons per day, and the most approved appliances for the manufacture of a superior article.

THE PATTON MOTOR CAR.

AMONG the latest developments of self-propelling street cars is that designed by Mr. William H. Patton, who has been giving attention to the question for several years, and which can now be seen in daily operation at Pullman, Ill.

At first sight the combination, which comprises a gasoline engine, dynamo, motor, and set of storage batteries, the latter being employed to render the generating apparatus as compact as possible and to enhance the reliability of the car, appears complicated, but the fact is the apparatus is exceedingly simple in operation. The weight of car complete is 14,600 to 16,000 lbs.

The motor car is shown in the accompanying illustration. In the centre of the car is a covered cab, in which the motive power is contained. The gas engine, which develops 10 h. p., is geared directly to the dynamo by means of an Evans friction pulley. The dynamo is wired directly to the motor, which is geared to the axle in the usual manner. The storage batteries are inserted in a branch circuit, and become charged by the portion of the current from the dynamo not used by the motor, which, when the load is light, is a large percentage of that generated.



PATTON MOTOR CAR.

When in ascending a grade or in starting, a large amount of power is called for, the electromotive force of the dynamo tends to drop, and the storage batteries furnish all the extra current required by the motor, until the load becomes normal. The dynamo is then capable of furnishing the required amount of current to the motor, and supplying a small surplus to the batteries, thus maintaining them always charged.

Each car carries 100 accumulator cells, two volts to the cell, supplying current of 300 amperes, developing eighty h. p. when needed.

The engine is placed in position on the trucks, entirely independent of the car body, and is geared direct to the dynamo by means of a friction pulley, no belts whatever being used. It is controlled automatically, and requires no attention. The electric motor is geared directly to the axle, and derives its energy from the dynamo current, this being supplemented when required by the reserve power from the accumulators; this additional current being automatically governed. In descending a grade, running on a level track, carrying a light load, or when car is not in motion, there exists a constant generating power, producing a surplus electric force. It is here that the accumulators play an important part, they being arranged to take care of the surplus that would otherwise be wasted. They are charged in series but discharged in multiple with the dynamo. Therefore, when any contingency arises where an extra amount of power is required, the accumulators, fully charged, are prepared to supply the required current.

The engine and dynamo occupy a space six feet square, completely housed, and with the accumulator cells conveniently stored away, the entire mechanism of the car is out of public sight. The car is operated by one man stationed upon either platform. Any desired degree of speed can be attained.

It is a well-known fact that a gasoline engine ordinarily has to be started by hand, but in this case the batteries are employed to perform this work by utilizing the dynamo as a temporary motor. The motor car is of sufficient power to haul one or more trail cars, as required.

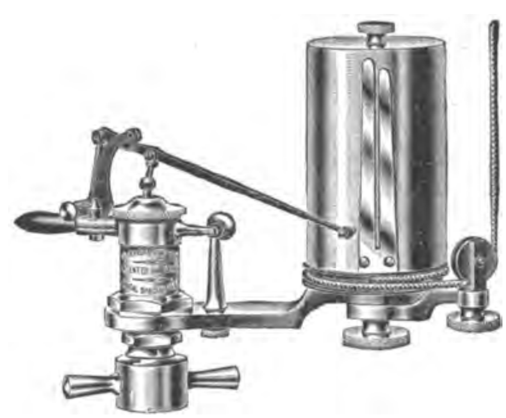
The cost of operation, it is stated, is 17 to 20 cents per hour, inclusive of wear of machinery. The officers of the company are: A. B. Pullman, president; H. H. Latham, vice-president; W. H. Dyrenforth, secretary; H. G. Bird, treasurer; Thos. Saunders, general manager; W. H. Patton, superintendent. The office is at 45 Lakeside Building, Chicago.

The successful tests at Pullman are said to have shown the practicability of the system, and the company are now prepared to furnish equipments and all details and particulars.

THE HINE & ROBERTSON INDICATOR.

THE accompanying illustration shows a straight line steam-engine indicator manufactured by Messrs. Hine & Robertson, 45 Cortlandt street, the peculiarities of which are the simplicity of the parallel motion, and the auxiliary spring by which it is held up to one working surface and the appearance of backlash prevented.

The guiding mechanism for the parallel motion is placed as near the fulcrum as possible, where the momentum will be the least. For a card of average height, a side movement of not more than one-eighth of an inch is necessary to allow the pencil to move in a straight line, and for so slight a movement very little mechanism should be sufficient. In this indicator this is accomplished by two rocking surfaces, one attached to an upright, and the other permanently fixed on the pencil arm. The one on the upright is circular, and the other of such form that when the lever rises and falls, the two roll together for a very



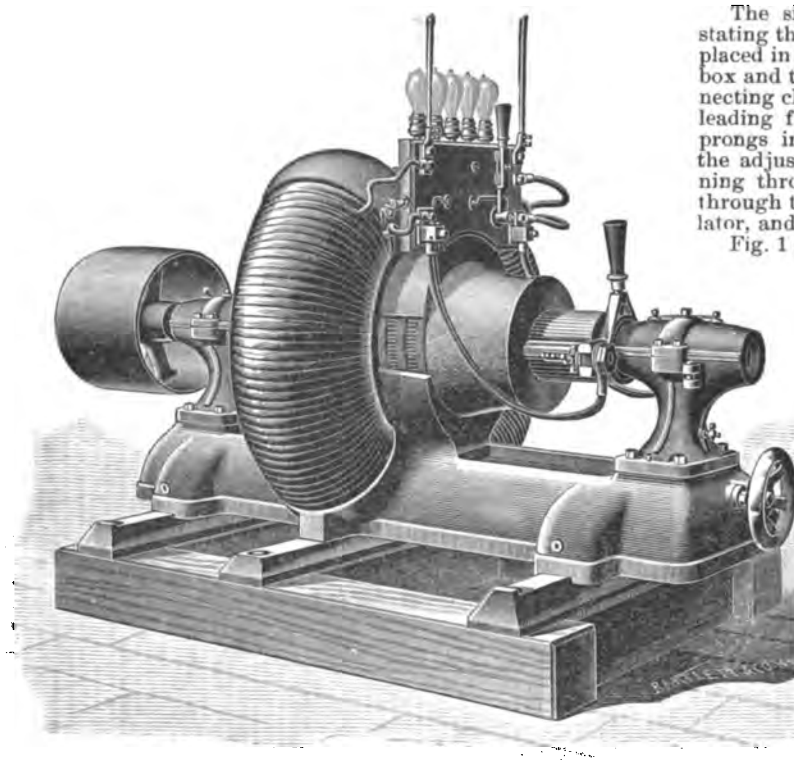
HINE & ROBERTSON STRAIGHT LINE INDICATOR.

slight distance and cause the pencil to move in a perfectly straight line throughout its full range. All that is required of the auxiliary spring is to keep these guiding surfaces in contact while the instrument is running. This spring is intended to take up all play that may ever appear in the joints and oblige the pencil to always follow in the same path. The first of these indicators made was subjected to the test of being run continuously nine hours a day on a high-speed engine for over a month, and showed no appreciable wear, what there may have been being taken up by the auxiliary spring, and the instrument being improved if anything by this hard usage.

The effect of the auxiliary spring on the main spring is to weaken it. This is allowed for in numbering the spring, and the scale is therefore the net resistance of the two springs. The moving parts of the instrument are very light and the weight is disposed so near the fulcrum that its little movement makes the momentum very slight and specially adapts it for the highest speeds.

A NEW TYPE "C. & C." DYNAMO.

The accompanying illustration is taken from a photograph of a 50 h. p. "C. & C." dynamo, placed on the market by the "C. & C." Electric Motor Co., 402 & 404 Greenwich street, during the past summer. The design is similar to that of the well-known circular field and consequent pole motor already so familiar to the public. It is said that there is not an electric light company in the country operating an incandescent circuit of any size that has not one or more of these motors in operation. The machine



New 50 H. P. "C. & C." Dynamo.

represented is wound for 500 volts and specially designed for power circuits. For a long transmission of power this machine can be specially wound to give perfectly automatic regulation under the very greatest possible variation in load. A substantial terminal-board is bolted to the upper pole-piece, and is provided with a heavy knife-switch for opening the main circuit. This board also carries the field and armature connections, all of which are of solid metal and in plain view. The commutator is of the most substantial construction, being built up of heavy copper bars insulated with the best mica. With proper care it will last for years. The mechanical construction is of the best throughout, skilled mechanics and the most improved machine tools being employed. The armature is wound to carry a much greater volume of current than the nominal capacity of the machine requires, thus making it practically impossible to burn them out by overheating. The circular shape of the magnets gives them the greatest possible development of power for least weight.

The 100 h. p. dynamo made by this company is of exactly the same form as the dynamo here illustrated, and is especially for street railway circuits, its high efficiency and mechanical excellence making it a favorite with station superintendents.

These dynamos are wound in standard sizes from 1 to 100 h. p. for electric lighting as well as for power transmission, and especially for isolated plants and for use in mills, office buildings, banks, etc,

Although the "C. & C." Electric Motor Company has but recently entered upon this field, the long list of companies now using their dynamos for lighting purposes is the best possible indication of the success with which they are meeting.

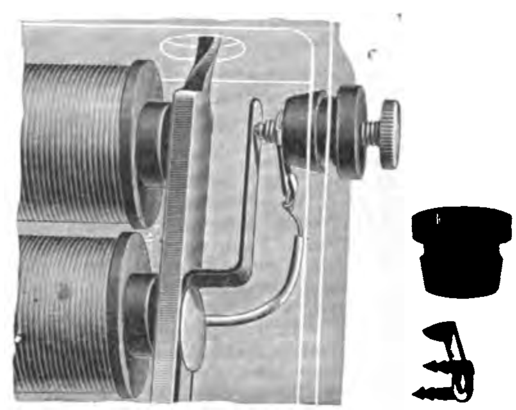
THE VARLEY COMBINATION ADJUSTING BELL SCREW.

Looking at the ordinary electric bell now so universally used, one would hardly think there is room for improvement. Perhaps not, so far as the user is concerned, but the manufacturer is ever on the alert for methods that will tend to better the bell without adding to its cost.

An exceedingly clever and valuable improvement in bell manufacture has recently been patented by Richard Varley, Jr., of Passaic, N. J., whose late inventions have attracted considerable notice. This device is called "A New Method of Assembling Bells." It consists of but three parts, which take the place of the somewhat complex method now in vogue for the adjusting attachment. These parts are the rubber stopple, Fig. 2, which affords an insulator for the adjusting screw and serves as a lock nut by compression of the rubber; the adjusting screws itself and a connecting clamp, Fig. 3. The office of this clamp is to connect the wire from the coils to the adjusting screw, it being held in position by the two prongs that fit into the small holes shown in rubber stopple.

The simplicity of this device may be briefly explained by stating the method of adjusting it to the bell. The stopple is first placed in position by forcing it through the hole in the side of the box and through the upright in the skeleton bell. Next the connecting clamp, which has previously been connected to the wires leading from the magnets, is placed in position by forcing the prongs into the stopple. This brings the hole through which the adjusting screw passes diametrically opposite the hole running through the stopple, Lastly the adjusting screw is pushed through the rubber stopple which forms at once a perfect insulator, and a lock nut for keeping it in position.

Fig. 1 shows the device complete attached to an iron box bell



Figs. 1, 2 and 3—Varley Bell Screw.

In skeleton bells a lug is cast on the frame in place of the regular binding post now in use. Through this lug is drilled a hole which admits the rubber stopple, as in the box bell described.

Aside from cheapening the materials necessary to make a bell, it greatly economizes the labor necessary for assembling the parts. It also adds to the bell's efficiency to the extent of preventing it getting out of adjustment by loosening of the screw, as the latter cannot turn in the soft rubber bed. In places where there is considerable jarring, such as in cars, factories, etc , the question of loose screws is an important one to be considered.

This valuable device has been placed on the market by Jones & Son, 602 West 22d street., New York.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

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COUNTING A NATION BY ELECTRICITY.

BY

T. C. Martin

I.

CENSUS-TAKING is a modern art. Ancient records are full of statistical information as to the number of people in certain nations at a given time, but it is to be deplored that the work was entrusted chiefly to persons of peculiar bent and aptitude for whom no other employment could then be found, namely, the romancists. In these days, such geniuses are restricted to fiction writing and the reportorial staffs of sensational papers; but at the remote period when man stood before all the great and complex facts of nature like a mere exclamation point, history was the only vent for his imagination. Hence it is safe to assume that very little of the numbering of the people at any time prior to the present century amounted to much. Every condition told against accuracy, even when it was sought in all sincerity, to true the record. The apathy or suspicion of the nation in regard to such a remote idea as its enumeration; the inability to secure a large force of skilled clerks; the obstacles of distance and primitive means of travel; the absence of comparative knowledge as to the best methods; and, finally, the doubt as to the treatment received by the returns when they were all in, even if every poll had been counted—these alone were drawbacks enough to stamp with uncertainty all the results that have come down to us.

As we have said, the art of census-taking is modern, and yet it is still, as practised in most countries of the world, as barbarous in its basis and methods as when just so many animals and a few herdsmen were told off into a patent lifeboat to try how a new start would improve social conditions. As a matter of fact, far as we here in America had gone in our plans for securing information not only as to the total of our population, but as to its peculiarities, we still used in the census of 1880 simple, crude tally sheets, which, save that the ruling on them was slightly neater, were practically the same as had done duty since the year 1. Anybody who will take up one of the old tally sheets, with its closely packed lines and serried columns, will see at a glance the difficulty and labor of transferring to them and thus massing the various interesting and important facts without which no census is now worthy of its name. The thing was as curiously inadequate to establish belief in its accuracy as is the cellar door with its chalk scratches that the saloon keeper brings to court to prove the length of a score. The only wonder to the writer is, that many of the clerks who toiled at the irritating slips of tally paper in the census of 1880 did not go blind and crazy.

II.

It was early evident that with our rapidly growing population, and the universal desire to see the returns before the generation it referred to had passed off the face of the earth, the old tallying, pencil-marking methods of 1880 would not do. The appointment of the Hon. Robert P. Porter, in April, 1889, as Superintendent of the Census, was soon followed by the naming of a commission to advise him as to the methods to adopt of tabulating census data, other than that of dallying with the primeval tally sheets. This commission, whose expert acquaintance with the subject is known to all, comprised Dr. J. S. Billings, Prof. Henry Gannett and Mr. L. M. E. Cooke. To this commission three schemes of tabulation were presented. That submitted by Mr. W. C. Hunt proposed to transfer the details given on the census enumerators' schedules to cards, distinctions being made in part by the color of the ink and in part by writing on them, the results being reached afterwards by hand sorting and counting. It should be stated here that Mr. Hunt's plan really represented the last refinement of the old methods, its author being an acknowledged authority with training in the Massachusetts Census, and now having charge of Population Statistics in the Eleventh Census as special expert agent. The next plan, that of Mr. C. F. Pidgin, contemplated the use of "chips," which should be duly assorted and counted. These chips were to be slips of paper of various colors embracing data printed in different colors so as to indicate the readings of the schedules. Thus the clerk seeking the most information would need the most chips, and, as in an analogous diversion, would wind up with having the most experience or valuable knowledge for his chips. Last, and foremost for the purposes of this article, came the system of Mr. Herman Hollerith. In this plan, the information given in the schedules was to be expressed upon cards by punching holes in them in certain positions. The tabulation from these cards was to be made by passing them through a press which would register their indications electrically on dials.

These three methods were now put to the test, four enumeration districts of the Census of 1880 in the city of St. Louis being taken. It was found that the time occupied in transcribing their contents by the Hollerith method was 72h. 27m.; by the Hunt method, 144h. 25m.; by the Pidgin method, 110h. 56m. The time occupied in tabulating was found to be as follows: Hollerith's electrical counters, 5h. 28m.; by the Hunt slips, 55h. 22m.; by the Pidgin chips, 44h. 41m. This settled it. The commission also estimated that on a basis of 65,000,000 population, the saving with the Hollerith apparatus would reach nearly $600,000. As a matter of fact, as the saving was based on an estimate of 500 cards punched per day, while 700 is the average, the saving is 40 per cent. more than was expected. It is needless to add that Mr. Hollerith's invention was adopted, and that an arrangement was entered into by the Government with its inventor.

III.

It had been from the first a matter of great interest to the writer to know how the Hollerith apparatus would go through the ordeal, and he made an effort more than once during the past six months to get such data on the subject as might prove of interest to the readers of THE ELECTRICAL ENGINEER. Each time, however, Mr. Hollerith replied that it would be better to wait until the system had given full evidence of its capacities, and that he was willing to abide by the results. His faith in his invention was certainly justifiable, but the efforts in various quarters to cast doubt on the figures obtained in the Census were such as to make a believer in the theory that electricity knows no politics, the more anxious to describe the work in progress. The statement by Mr. Porter that the population of this great republic was only 62,622,250 sent into spasms of indignation a great many people who had made up their minds that the dignity of the republic could only be supported on a total of 75,000,000. Hence there was a howl, not of "deep-mouthed welcome," but of frantic disappointment. And then the publication of the figures of New York! Rachel weeping for her lost children and refusing to be comforted, was a mere puppet-show compared with some of our New York politicians over the strayed and stolen of Manhattan Island citizens. The work of counting all those Charlie Rosses might still be going on, but perhaps this city now extracts consolation from the fact that her trans-Atlantic sister, Liverpool, finds herself similarly bereaved. As to the low "grand total" of population, Mr. Porter has the grim satisfaction of pointing to Canada. Her showing for the ten years is so bad that even if she were to call in whole provinces of the Old World to even up her ranking in the New, she would still be short many hundred thousand on the old bases of estimate. The happy truth is that as Mr. Hollerith, himself no mean mathematician, has shown, while the race is not multiplying so fast as before, its individuals are living longer. This is a state of affairs that all of us over 25 years of age, whether Republicans or Democrats, can view with equanimity. They who are loved on high no longer die between two Censuses.

Herman Hollerith.

It is needless to say that in all this hurly-burly of discussion over the Census and its figures, the electrical counting system came in for its share of abuse. Just why it would not work was never made clearly apparent, for all that appeared in print derogatory to the mechanism merely went to prove its wonderful simplicity and inability to go wrong. In one or two instances, the attempts to show faultiness were so puerile as to suggest that their author was either malicious or was being imposed upon. Later on, the absurdity of some of these criticisms will be shown, but it will suffice to say that they only made the present writer more anxious and keen to detect a flaw in the system and apparatus, if flaw there were. After a scrutiny as close and careful as it could be made, it seems only possible to say one thing, namely, that the apparatus works as unerringly as the mills of the Gods, but beats them hollow as to speed. The effort will be made now to describe the system in actual operation, as witnessed two or three weeks ago, at the different branches of the Census Office in Washington.

IV.

The Eleventh Census is still of so recent date that many of the readers of this journal will remember the broadsheet schedules that were presented to them by the official enumerator to be filled up. Each of these schedules provided for some thirty details regarding any of 10 individuals. Such a sheet would therefore serve for a family or household of ten people, but as a matter of fact it was found that the average fell slightly below five; so that in the neighborhood of 13,000,000 of these schedules were sent into the Census Office, representing the work of about 50,000 enumerators. To-day these sheets, tied up in about 50,000 packages, have been appropriately deposited in one of those time honored storehouses of vital statistics—a church—and constitute literally our modern Book of Numbers. The first thing, however, to be done with these myriad records was to get at their gross totals, and upon this work the Hollerith system was put through a kind of preliminary canter. The ingenious machine shown later in Fig. 5 was fitted with a small numbered key-board of ordinary construction, the keys being connected electrically with the dials, which were so arranged that one of them would furnish the grand total of families as a check against the separate totals of the others for families of different sizes. The keys were in three rows, of which the top one, stamped from 1 to 8, recorded the number of families in each house. The other two rows nearer the manipulator were numbered from 1 to 10 and 11 to 20, and recorded the persons in each family. The enumerators having given this information in a little space provided at the top of their schedules, it was easy for a quick-eyed and a quick-fingered clerk to transfer the items to the dials of the machine or make special note of such rare families as exceeded 20 members. Evidently the multiplying of the number of families by the number of persons in each class would, if correct, yield the result indicated by the "total;" and hence the work was capable of very thorough check. The expertness acquired in manipulating the Hollerith machines may be inferred from the fact that some of the women tabulators thus counted as many as 50,000 persons a day, or the inhabitants of a good-sized city. The average for the women tabulators, who worked in the day time, was about 47,950 each; while the men tabulators, handicapped perhaps by coming on at night, averaged 32,935.

In this ingenious and expeditious manner, thanks to the Hollerith machines, the first, or "Dwelling House" count of the whole population of the United States as it stood on June 1, 1890, was made. Practically only six weeks were needed for the gigantic task. The announcements from the Census Office as to population of various sections followed each other rapidly, and a "rough count" for the whole country was ready as early as October 30, 1890. The last returns did not reach Mr. Porter until November 10, but he was able to issue his celebrated bulletin, giving the "official count" of 62,622,250, exactly a month later, namely, on December 12. Yet all the figures had been thoroughly checked; in reality, the people of the United States had been counted twice over. As Mr. Porter put it at a dinner given by the chiefs of the Census Office to celebrate the occasion, "For the first time in the history of the world, the count of the population of a great nation has been made by the aid of electricity" and every single one of our 62 millions "had marched as it were under the vision of the young men and women who had done such remarkable work with such extraordinary rapidity and precision."

V.

But all that we have secured so far is the total of population and a few necessary details as to size of family, and persons to dwellings. This is most important, but, as has been stated above, there are between twenty and thirty details given on the schedules as to each of the 62 millions, and pretty nearly all of those details are of the first value in revealing the make-up of the nation. The problem that arises is, how to extract the honey from the lion's jaw; how, out of this enormous mass of returns, to elicit the facts that shall tell us what we want to know about the national characteristics—whether we are being Latinized or Teutonized in blood; whether the agricultural population increases in inverse ratio to the farm mortgages; whether city children are born merely to stimulate the trade in small coffins; whether naturalization is fashionable; whether attendance at school promises a higher state of education; whether protected industries employ many or few hands; whether a large or small proportion of the people suffer from mental or physical defect; and whether with a rising standard of comfort fecundity of the race declines. These are interesting questions, and something more. Yet it is very difficult to arrive at such combinations, and until now the obstacles have proved almost insurmountable. Thus, for example, in the Census of 1880, although the returns included statements as to the conjugal condition of each and every one of the 50,000,000 inhabitants of the United States, no attempt was made to tabulate it in any way, and hence to-day we do not know what proportion of the population is married or single!

Fig. 1.—Hollerith Keyboard Punch.

It was the absence of methods for getting speedily and surely at such results that arrested the attention of Mr. Herman Hollerith, while engaged in work upon the Tenth Census, that of 1880, and led him to the invention of the apparatus described in this article. He saw that with increasing population and increasing complexity of data, the difficulties were becoming such that unless improved means of compilation were devised, the work must be abandoned in despair or become more incomplete and unsatisfactory each decade. On the other hand, with the aid of new facilities, not only might time and money be saved, but the data could be thrown into combinations full of suggestion and teaching, but which had been utterly beyond reach before. Such facilities Mr. Hollerith has furnished in his electric tabulating system. The fundamental idea of this is, as said, to punch holes in cards so that the positions of these holes will correspond to certain data, and then to pass these cards through presses by which the perforations in the cards are made to control the operation of electromagnets or groups of magnets, which in turn energize counting mechanism or sorting boxes, or will bring both into play at once. There is no need to go into the history of the stages by which Mr. Hollerith has perfected his invention, but having already described how part of it was used for the "enumeration" and primary tabulation, it will suffice to show in what manner it performs the further and more delicate and exacting duty of compilation.

VI.

Once more, then, we come back to the returns sent in by the 50,000 enumerators. In order to transfer the particulars as to each individual from these 13,000,000 schedules, Mr. Hollerith devised the machine shown in Fig. 1, known as the "keyboard punch." It is about the size of a typewriter tray, having in front a perforated punch-board of celluloid, translated in Fig. 2. Over this keyboard swings freely a sharp index finger, whose movement, after the manner of a pantagraph, is repeated at the rear by a punch. The movement of the punch is limited between two guides upon which are placed thin manilla cards $6\frac{5}{8}$ inches long by $3\frac{1}{4}$ inches high, with the lower corner slightly clipped. The keyboard, as will be observed, has twelve rows of twenty holes, and each hole has its distinctive lettering or number that corresponds to the inquiry and answer respecting every person. Hence when the index finger is pressed down into any one of these holes, the punch at the back says "ditto" by stamping out a hole in the manilla card. At first glance, perhaps, the keyboard looks complicated, but it is scientifically grouped, and, as the writer can testify, it is very readily learned. For such inquiries as are answered by one of a very few possible classes—sex, for example, which recognizes only two parties in the State—

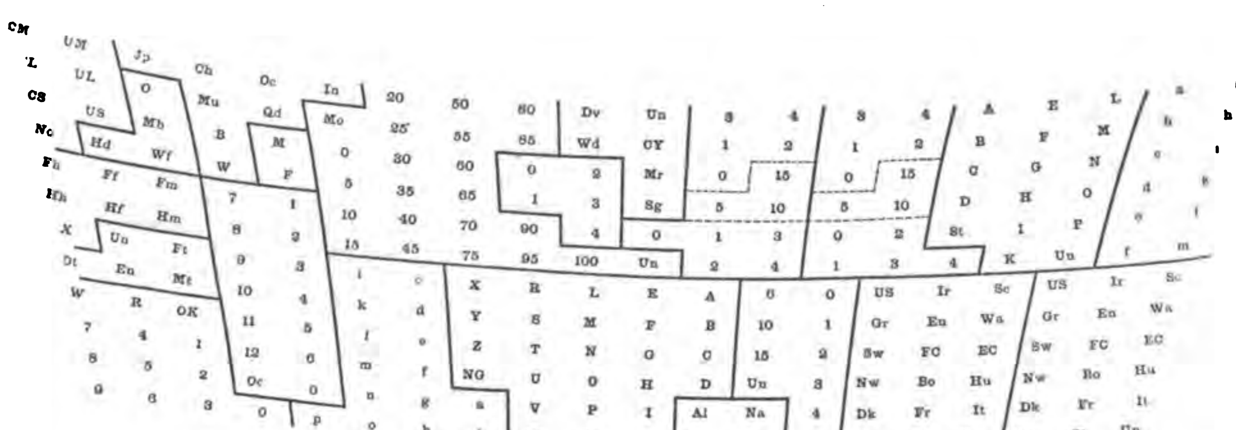


Fig. 2.—Symbols of Holes in Hollerith Census Keyboard.

the answer is simply "male" or "female," or "M" and "F," So, too, in regard to conjugal relationships, where the answer would be either single, married, widowed or divorced, and one punch suffices for each of these conditions of freedom or servitude. These holes may easily be found in "Dv," "Wd," "Mr.," or "CY," the last of which means that the person was married during the Census Year. Where, however, the answers would cover a wider range of classification, as in age, running from 1 to 100, recourse is had to a combination of two holes, the first indicating a group, as from 25 to 29 years, while the second hole designates the detail single year in that group. Up in the left-hand corner are double letters that bear upon the status of combatants in the Civil War, while down in the lower right hand corner are other double letters that tell one's place of birth and the place of birth of one's forebears.

To assist the clerks in memorizing the keyboard for punching, classification lists were used, which show that exactitude was sought without making it troublesome to the puncher. Thus, "Ka," standing for Germany, stands also for many divisions of the German Empire that a clerk without some such guide might be inclined to hand over again to France, Austria or Denmark. As regards the United States, each Commonwealth is designated by two letters, the first capital letter being the group, such as North Atlantic, while the small letter is the particular State. Thus, Georgia is "Bb," while Connecticut is "Ag." Now to get the run of these combinations is not difficult when once you have started. The larger percentage of all the population of any State is born within its borders, for which the hole marked "St." is provided, or else it is from two or three States near by. It follows, therefore, that, after all, the symbols "come easy" with each lot of schedules. The same remark holds true with regard to occupations. A clerk punching the card for an agricultural district has but few symbols to bother about. In many a New England town "cotton mill operative" will fit most cases. Down the Wyoming Valley, of Pennsylvania, coal miners will be apt to predominate; while out in California, fruit growers will be numerous. It will thus be seen that these innocent combinations, which a leading New York newspaper has epithetted as "refinements of torture," are no more burdensome on the memory than the details of a typewriter keyboard. On the contrary, they are vastly interesting. That the work of punching became as easy as any other

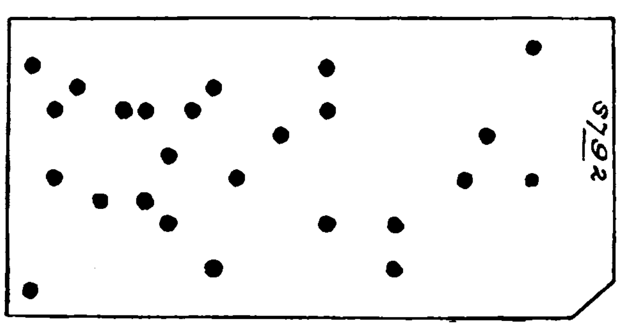


FIG. 4.—COMPLETE CARD FOR ONE PERSON.

task requiring ordinary intelligence is shown in the fact that the estimated average of 500 cards per day per clerk resolved itself very soon into an actual average of 700. It is stated that some of the more expert punchers, working from 9 A. M. to 4 P. M., have done 1,100 cards, with an aggregate of 18,700 holes, each card having 17 holes in it that relate specifically to the individual whose life history is thus condensed. Even close upon 2,000 population cards have been done in a day.

VII.

After the cards leave the punching clerks, they are kept in their Enumeration Districts, and they have now to be further punched to show the exact locality they belong to, —*i. e.*, the civil division of which the enumeration district formed a part. For this purpose the space of about one inch across the left-hand end of the card was left blank, no portion to the left of a fictitious line being punched on the keyboard punch. This space is further divided by imaginary lines into 48 squares, in the combinations of which every enumeration district can be recorded, and it is perforated by means of the "Gang Punch," shown in Fig. 3. The combination for any given enumeration district is arranged in this, and then all the cards of that district are passed through. From three to six cards can be punched at a time, hence the name, and pressure may be applied by either the hand or the foot. When this is done, the cards are complete, as shown in Fig. 4, which is a fac-simile,

FIG. 3.—THE HOLLERITH GANG PUNCH.

slightly reduced in size, of the card for the head of a family in Chicago.

So familar do the clerks become with the position of the holes in these cards, they can read them off at a glance. As a means of verifying, however, a "reading board" is provided for that purpose, the same size as the card, and having also each of the 240 abbreviations in a quarter-inch space, so that when a perforated card is put on this templet the abbreviation will show wherever a hole has been punched. This templet is, practically, a reduction of the original keyboard, and is about the size as our illustration of that part of the apparatus.

In one of the newspaper articles appearing recently on the subject, two alleged samples of these complete cards were given in order to show that the "chances of error were largely increased by the mechanical devices employed," while "there was small possibility of detection." The funny part about the exposé in question is that both cards lacked the impress of the gang punch, and therefore were not part of the Census record at all. In other words, they were imperfect cards that had been thrown aside by the punchers themselves, and had not even reached the Hollerith electric machines, which would have been as prompt and unerring in their rejection as are bank tellers in casting out false coin. The present writer, while in Washington, asked specially as to imperfect records, and was taken into the little room where cards rejected by the machines were being set right by reference to the original schedules. A glance at the handful of men there, revising the work made by the handling of half a million cards daily, showed the percentage of wrong cards to be very small. Where the errors were "Inconsistent," that is, where a child of 10 would be registered as of no sex, the machine would sooner or later spot the mistake and refuse to count the card. As to "consistent" errors, those namely in which a man who was a policeman might be punched with unconscious humor as a poolroom-keeper, it is safe to say that such errors were necessarily very few, if only for the reason that it is at least as easy to punch in the right hole as in the wrong one; and these errors would, moreover, on a mathematical basis, be less likely to occur in dealing with holes that are a quarter of an inch apart, than where the same record was made on lines only one-eighth of an inch apart. But besides the natural checks on errors consistent and inconsistent, was the further check of a frequent examination of the work as it proceeded day by day and hour by hour.

VIII.

These wonderful little cards have now come to stand for over 62,000,000 people. Each card is not only full of holes, but has its number, and is ready for the next stage of treatment, when each of the holes will tell its story in just the same manner as the perforations in an organette strip will cause certain notes of music to be played. The cards are stacked up on end in tin boxes, measuring 20 x 7 x 3½ inches, each box taking a trifle less than 2,000 cards. We here have a distinctively new American industry, that of canned statistics. In front of each tin box is a label stating its contents. These boxes are kept in racks in the basement of the Census quarters in the Interocean Building. They line up ten miles long. Across the street, in the old church, are the enumerators' schedules from which they were made. Those schedules might every one of them be burned up, and the Eleventh Census could be taken over again from beginning to end, by means of the little slips of manilla in these modest little tin cans. If the record relating to each person were written in a line across a strip of paper, and the lines were half an inch apart, the roll for the nation would be nearly 500 miles long. Truly here, on these shelves, is a Liebig extract, for each can contains the essence of 2,000 human lives. In this cellar Herbert Spencer could immure himself and study sociology with the aid of 1,000,000,000 independent facts about a single nation, but the labor-saving Hollerith machines upstairs will give them to him in significant totals down to the last degree of analysis.

IX.

Mounting by elevator to one of the upper stories of the Interocean Building, one reaches the departments where the machines are mainly in use, and where one is again impressed with the fact that women are entrusted with much of the work. As one enters, the ear catches the sound of crisp bell ringing, for all the world like that of sleighing. This music comes from the Hollerith machines, on each of which a bell, intercalated in the circuit, rings every time a card is counted, while its failure to ring indicates that there is something wrong with the card, or that it has not been slipped in properly. When the office was visited by the writer, there were 81 clerks at the machines, and their work showed 434,493 cards counted and 121,853 sorted, or a total of 556,346 for the day, making an average of 6,868 per clerk per day. In other words, the force was piercing its way through the mass at the rate of 500 feet daily, and handling a stack of cards nearly as high

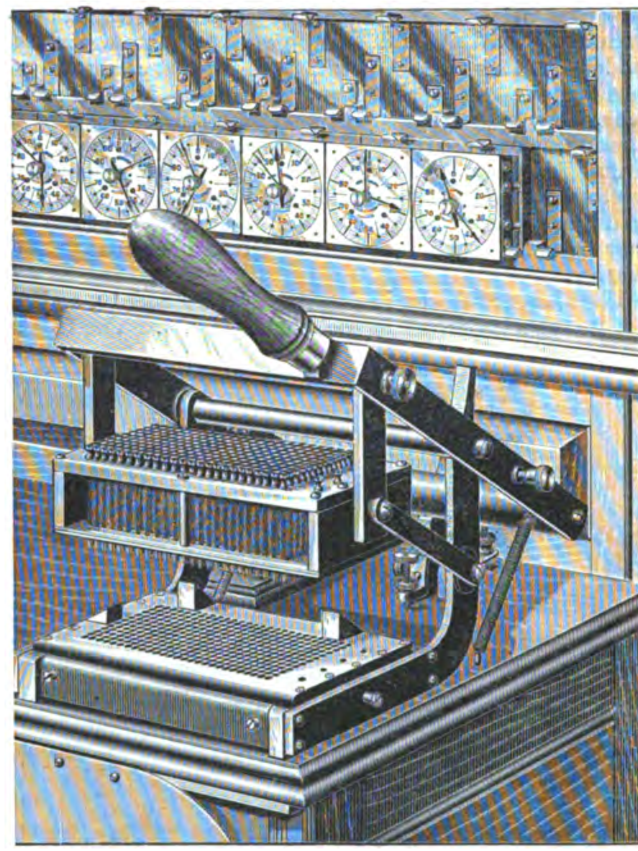


Fig. 6.—Perspective of Circuit Closing Press.

as the Washington Monument. The Hollerith machine, at which the clerks are seated, is shown in Fig. 5. It consists of three main parts, namely, the press or circuit-closing device, the dials or counters, and the sorting boxes. The press is shown in perspective in Fig. 6 and in detail in Fig. 7. It

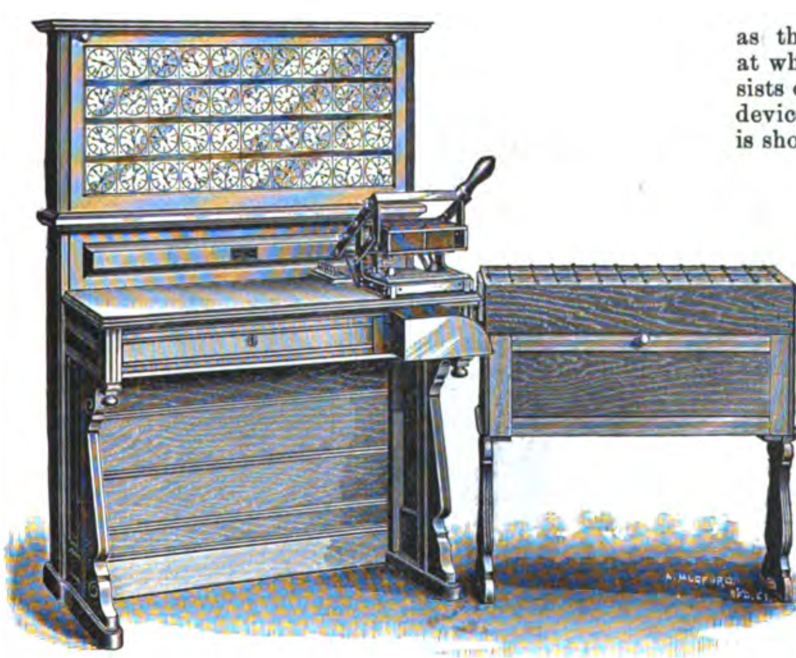


Fig. 5.—The Hollerith Electric Tabulating Machine.

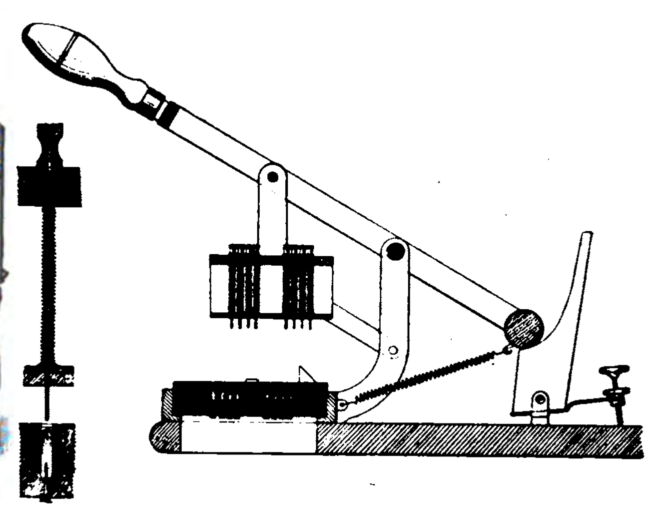


Fig. 7.—Details of Circuit-Closing Press.

consists of a hard rubber plate, provided with 316 holes or pockets, the relative positions of which correspond with those of the holes in the keyboard and gang punches. Each of these pockets is partially filled with mercury, and they are thus in electrical connection, when the circuit is closed, with the binding posts and switchboard at the back of the machine, as shown in Fig. 8, where a portion of the wooden case is broken away. Above the hard-rubber plate swings a reciprocating pin box, which is provided with a number of projecting spring-actuated points, so hung as to drop exactly into the centre of the little mercury cups below. These pins are so connected that when a punched card is laid on the rubber plate against the guides or stops and the box is brought down, all the pins that are stopped by the unpunched surface will be pressed back, while those that correspond with punched spaces pass through, close the circuit, and count on the dials. The circuit is really closed first through platinum contacts at the back of the press, and not seen in the cut. In this way no difficulty is experienced from the oxidation of the mercury from the spark, as would be the case without this precaution.

The dials are shown in detail in Figs. 9 and 10, and may also be seen grouped in position in Fig. 5. The front of

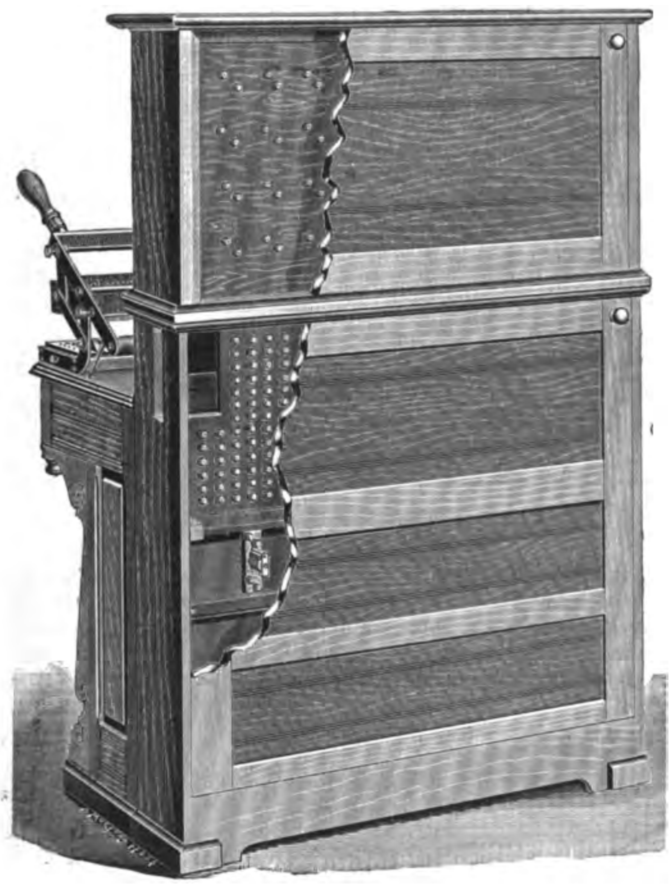


FIG. 8.—BACK OF HOLLERITH MACHINE, SHOWING SWITCH BOARD AND BINDING POSTS.

each counter is three inches square, and, as now made, consists of paper ingeniously coated with celluloid, ensuring a smooth, bright, clean face. Each dial is divided into 100 parts, and two hands travel over the face, one counting units and the other hundreds. The train of clockwork is operated electrically, by means of the electro-magnet, whose armature, as it moves each time the circuit is closed, carries the unit hand forward one division, while every complete revolution actuates a carrying device, which, in turn, causes the hundred hand to count. In this way each dial will register up to 10,000. A noteworthy feature of these ingenious little dials is, that they can quickly be re-set at zero, while they are also removable and interchangeable. The electrical connections are made simply by slipping them into the frames and clips shown in the upper part of Fig. 6.

The third element in the system is the sorting box shown in Fig. 11 in perspective, while Fig. 12 is a diagram of its mechanism. The box is divided into numerous compartments, each of which is kept closed by a lid. As seen in Fig. 12, the lid L is held closed against the tension of the spring S by the catch a at the free end of the arma-

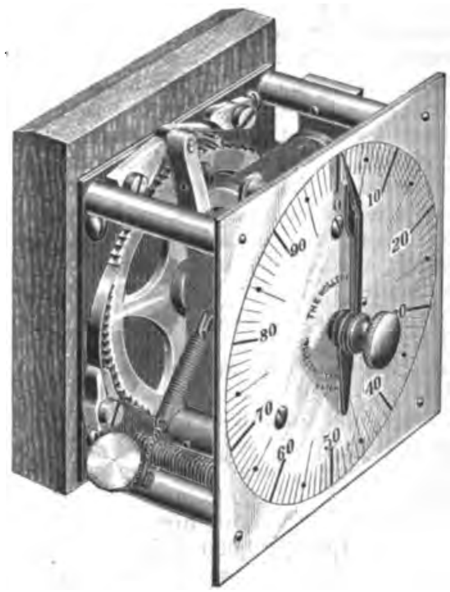


FIG. 9.—COUNTER.

ture A. If the circuit is closed, by the press on the machine, through the electro-magnet E, the armature **A** is pulled down, releasing the trigger of the lid L, which is at once thrown up by the spring S, and remains open until flipped back by a slight touch of the operator's hand. The connections with the machine are made by means of the short cable seen at the left of the sorting box. In the cut the wires are shown attached to binding posts on a small board, but a minor change has been made by which the board is pushed in between contact clips in the machine, thus saving valuable time by obviating the necessity of screwing and unscrewing so many binding posts whenever it is desired to remove the box for any reason.

X.

If now, it is desired to know in a given enumeration district, or all of them, the number of males and females,

FIG. 10.—BACK OF COUNTER.

white and colored, single, married, widowed, &c., the binding posts of the switchboard corresponding with this data are connected with the binding posts of the dials on which these items are to be counted. If it is also desired to assort the cards according to age groups, for example, the binding posts of the switchboard representing such groups are connected with the clips into which the sorting box plug fits. The circuits being thus prepared, when a card is placed in position in the press and the handle of the pin box is depressed by the operator, so that the circuit is closed through each hole in the card, not only will the registration be effected on the counting dials, but the sorting box that has been selected for a given age group is opened. The operator releases the handle, removes the card deftly from the press, deposits it in the open sorting compartment with her right hand and pats the lid down again, at the same time bringing another card into position under the press with her left hand. It is done much more quickly than it is described. When all the cards in the tin case of any district have thus gone through the press, the record taken from the dials will show the number of males, females, white, colored, &c., while the cards will have been assorted into age groups.

This is well enough, and evokes our admiration, but the Hollerith machine is capable of much more than this. In statistical work, it is found that the most valuable information does not consist in these elementary items, but in facts that are more difficult to obtain, namely, combinations of these items. Thus, it is interesting to know how many dwellers in this country are males and how many are females; also how many are white and how many are colored. But it is at least as essential to know how many of the white males are native born or foreign born, and how many are the children of native born or foreign parents. Hence it is desirable to provide means for counting not simply the number of white males, but the number of white males, native born, of native parents. Mr. Hollerith's machines do this as easily as they do the lighter work. The old familiar principle of the relay is brought into play very ingeniously by means of the special but simple form of relay shown in Fig. 13. These relays are mounted together in the racks at the bottom of the machine as illustrated in Fig. 8. In the case just suggested, the wire is brought from the binding post of the switchboard corresponding to male to one contact of the relay operated from the binding post corresponding to white. From this relay the circuit runs to another relay operated from the binding posts that correspond to native birthplaces. Thence again the circuit goes to the relay operated by the binding post that corresponds to native born father, thence again to the relay operated by the binding post corresponding to native mother; and finally to a counter. It will be seen therefore that the counter will only be operated when a card which has been punched for "native," "white," "male," "native-born father," and "native-born mother," and of the given age, is put under the press. If the card is not so punched, the circuit remains open at one or more points and no counting is effected. Evidently the most complex combination can be effected in this manner. An elementary manner of building up the combination is shown in diagram in Fig. 14. It is simply a question of arranging the counting dials and the relays, or, if desired, the sorting boxes can be treated in the same way. When the machine is once connected up, the combination sought yields its results just as readily as though it were a single item. It is obvious, too, that multiple contact relays could be used, carrying the ability of the machine even further, if one wanted to do it in that fashion. Moreover the machine is not confined to tallying one set of facts, but will take several at one and the same time, being limited only by the number of counters.

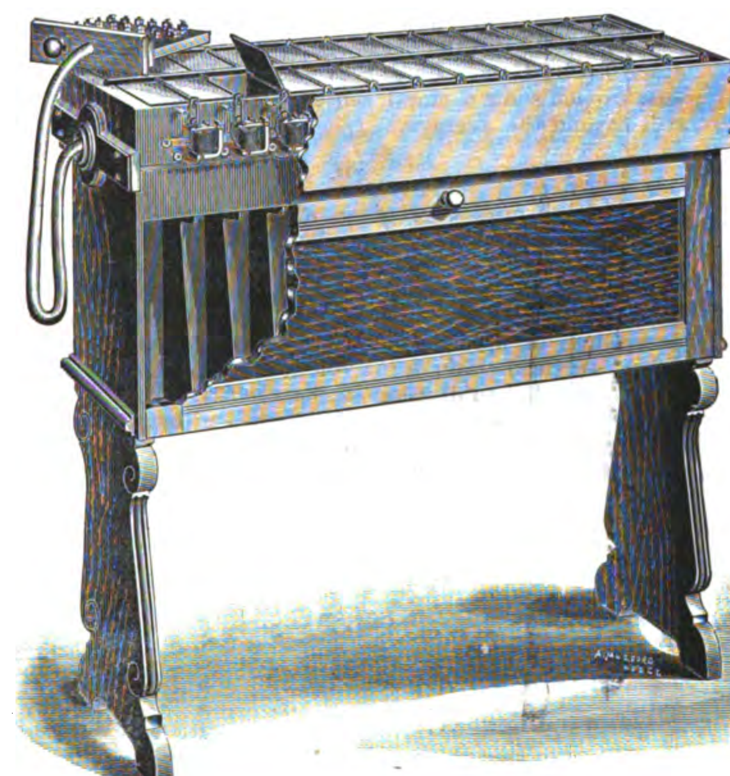


FIG. 11.—HOLLERITH SORTING BOX.

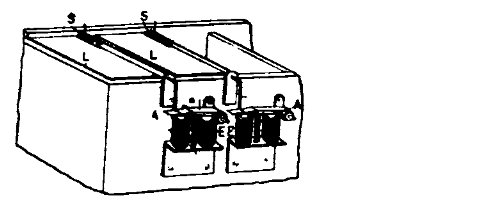


FIG. 12.—DETAIL OF SORTING BOX AND CIRCUIT.

FIG. 13.—RELAY.

There is another side of the Hollerith method. We have just indicated refinement in detail of one kind, but the machine lends itself to analytical work not less than synthetical. In statistical investigation the analysis naturally becomes finer as the area enlarges, and here the sorting box is of great service. As has already been stated, the cards are primarily massed in enumeration districts. For such small areas, the information required groups the population under comparatively few heads. In practice it is found that such classification can generally be counted on the 40 dials that the machine embraces normally as a full equipment; and the arrangement is made accordingly. But while counting this classification, the cards can also be assorted into groups that will form the basis of the analysis for the next larger group of territorial areas; so that if the cards are divided into twenty groups, we shall have at the next handling of the cards, a classification of 20x40, or 800 heads. If, at the next step, we subdivide each one of these twenty groups into twenty more, the third handling of the cards will give us 20x20x40 or no fewer than 1,600 heads. Thus a very few manipulations will give an extraordinarily fine degree of analysis, and the compilation will have a value from its minuteness that could be reached in no other way.

XI.

It is estimated that each of the machines thus compiles and registers information daily that would require the efforts of 20 clerks if sought by the old system of tally sheets. But that is not all. Added to the ability to secure special details, finer analysis, and the economy in time and

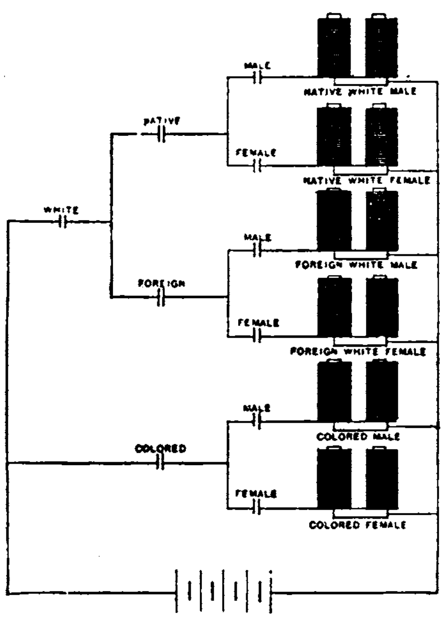


FIG. 14.—METHOD OF ARRANGEMENT FOR COMBINATION COUNTING.

labor, we have the greater accuracy. The machine automatically throws out any card that is wrong. Suppose, for instance, that age or sex has not been punched. Where there should be a hole for the plunger pin to go through, closing the circuit, the card is intact. The circuit is open, and the monitor bell just to the left of the press, refuses to give its cheery signal of correctness. It is then a very easy matter to refer back to the schedule stowed away in the old church across the street and fill up the deficiency by the paradoxical process of making a hole. Suppose it was desired to connect up the machine so that only cards for New York should be counted. A missorted card belonging to Chicago would at once be rejected with as much decision and hauteur as though it were a Knickerbocker turning the cold shoulder to a pork packer. The gang punches of the two cities not agreeing, the wrong cards would leave the circuit open. Moreover, the same indications are made of course by the same holes for all like data. If the cards of electrical engineers were assorted correctly, the hole designating the fact would show daylight through a thousand of them. If a banker fell among the bunch of thieves, the fact would be revealed again in a second, and he would be rescued from such bad company. That all are butchers in a batch of cards purporting to represent them, is simply ascertainable by taking one of their own meat skewers and sticking it through the holes that announce the fact. But this could evidently not be done with written cards, and the digging through the 150 tons of them for such as had thus gone astray would be a job preferably postponed until such time as second sight becomes an every-day accomplishment for government clerks.

It should be pretty clear by this time that the probabilities of error in reality narrow themselves down to the punching, and, as has been pointed out, even then the only errors that escape detection are those in which the information given, while it may not furnish the exact fact, is still consistent with the other facts punched. Even these could be eliminated by comparison or check of every card, but it is surely hypercritical to complain of results so close to absolute accuracy. It is to be borne in mind, too, that a card wrongly punched involves only the possible miscounting of a single unit, whereas in all previous methods the counting up on sheets has involved possible miscount at each footing up of a column. Another point worthy of remembrance is that a large part of the punching was done by women clerks, a fact that augurs well for its conscientious performance. Whether in the dull routine of American office toil or in the discharge of the Amazonian duties described by Robert Louis Stevenson in his South Sea letters, women show a moral sense of responsibility that is still beyond the average.

XII.

As a few figures were given of the records made with the punching machines, it may be worth while, in passing, to cite some that relate to the tabulation work. It has been stated that at the time of the writer's visit to the Census Office, 81 clerks had handled 556,346 cards that day, an average of 6,868 each. The "roll of honor" shown below, obtained through the kindness of Mr. H. Sutherland, chief of the fourth division of the Census Office, includes the best records on the work of tabulation for a week at a time, with the name of the clerk, showing the number of cards and the average "readings" per day.

Name.	Week ending—	Av. per day.	
		Readings.	Cards.
Alexander, Maurice.....	July 25th....	9	13,856
Richardson, Mrs. Z......	Sept. 26th....	7	11,351
Castillo, Angelo J......	Oct. 3d......	5	10,766
Johnston, Orphella......	Aug. 22d....	6	9,515
Werner, Edgar V.......	Oct. 3d......	5	9,475
Stockbridge, Lucetta....	Aug. 29th....	4	9,230

Below are given the six highest individual records for any one day:

Name.	Week ending—	Readings.	Cards.
Alexander, Maurice. ...	July 9th.....	9	**19,071**
Wasner, Mary..........	Oct. 2d	5	**17,814**
Castillo, Angelo J.......	Oct. 21st.....	7	**15,119**
Richardson, Mrs. Z......	Sept. 9th....	12	**15,068**
Ourand, Mrs. Rachel E..	Oct. 9th. ...	10	**13,327**
Mesick, Hattie S........	Sept. 4th.....	11	**13,067**

In explanation it may be stated that to run so many cards through the machine and take a reading means that each card has to be put under the press and counted for each district. Then the 38 dials in the face of the machine are counted, the results are set down according to the requirements of the various result slips furnished for the purpose, addition, verification—and correction, if needed,—are made, and the clerk then starts a new district. The day's work extends over 6½ hours, and these totals therefore show very creditable speed and expertness.

XIII.

The writer made a point while inspecting the Hollerith system, of ascertaining the opinion of the Superintendent of the Census as to the work. Mr. Porter stated emphatically that the office could not have dispensed with it. To use his own words, "he could not have got away from it." In a recent address before the American Statistical Association, Mr. Porter also dwelt upon its value for the special compilation of the statistics of mortality. Mr. W. A. King, chief of the Mortality Division of the Census Office, in a statement with regard to his own line of investigation, dwells very forcibly upon the superiority of the Hollerith apparatus for reaching detailed and accurate results. Mr. King was on the staff of the Tenth Census of 1880, and hence, is familiar with the tally sheets of that epoch. Speaking of them, he says: "In a compact tally sheet, the spaces in which the various details are tallied are close together and a very slight movement of the pencil is sufficient to produce an erroneous tally; and with any kind of a tally sheet the results sought are not known until the tally is completed, and if in the figures thus obtained a discrepancy is found by comparison with previous work, it is impossible to do more than determine the *gross* error. No means exist of locating the particular cases in which the error was made. If a re-tally is made, the error in that particular may be corrected while others are changed, or it may be made worse."

The Rev. Fred. H. Wines, another veteran of the Tenth Census, and now in charge of the statistics of Crime, Pauperism, and Benevolence, the schedules for which come from the various institutions, says in a most interesting document on the general features of the Census: "The essential difference between the Eleventh Census and that which preceded it was the adoption of the card system for the tallying of results and the use of the newly invented Hollerith electrical machine for counting the cards. Too much cannot be said in praise of this machine which has enabled us to compute results with much greater rapidity and accuracy than by the old method of tallying, besides giving the opportunity to make a much more thorough analysis of the figures." Mr. Wines remarks on the striking manner in which the cards become endowed with meaning and attributes, and adds that for the computer, "a card which means nothing to the uninitiated is converted into a pauper or a criminal, whose sin and suffering are as palpable as if the man himself were bodily present in the room."

It will be obvious that the special use of the Hollerith machine for mortality, crime and pauperism figures renders it equally available for other work. It would easily group, classify, and sum up, for instance, the multitudinous details of telegraphy, telephony or electric light and power. As a matter of fact, it has for some time past been in use by the Board of Health of New York City. This general utility of that which has given such remarkable proof of its ability in the Eleventh Census was recognized by the Franklin Institute, in conferring on Mr. Hollerith the Elliot Cresson Medal. The Committee on Science and the Arts of the Institute, after seeing the system in operation at Washington, said: "They are of the opinion that it is invaluable wherever large numbers of individual facts are to be summed and tabulated. They consider that the inventor is deserving of the greatest commendation for this useful and novel application of electricity, and strongly recommend that he be granted for his invention the highest award in the gift of the Franklin Institute."

But perhaps the most practical demonstration of the value of the Hollerith system is its adoption by the Governments of Canada and Austria for their respective censuses. This is the solid appreciation that an inventor most enjoys.

XIV.

It might seem that to have invented such a system as has been described, by which a great nation has been counted for the first time by electricity, is glory enough. But Mr. Hollerith, who, by the way, is a Ph. D. of Columbia College, is the patentee of the inventions upon which the Carpenter electric braking system is based, and has now worked out a novel and valuable integrating device which is deserving of description. In the compilation of census statistics, such as those of population, mortality, etc., or the bulk of the work to which the Hollerith apparatus has heretofore been applied, the person forms the unit, so that each card represents simply that unit. But the census includes agricultural, manufacturing and similar statistics, and it is evident that in the figures of agriculture or manufacture, while a card might represent a farm or a factory unit, the *value* of that unit might vary greatly. Thus it might be a farm of a hundred acres or of five hundred, and we would thus have to record *amounts*. This can be readily done by such a machine as that here shown in Fig. 15. The cards could be punched, as already described,

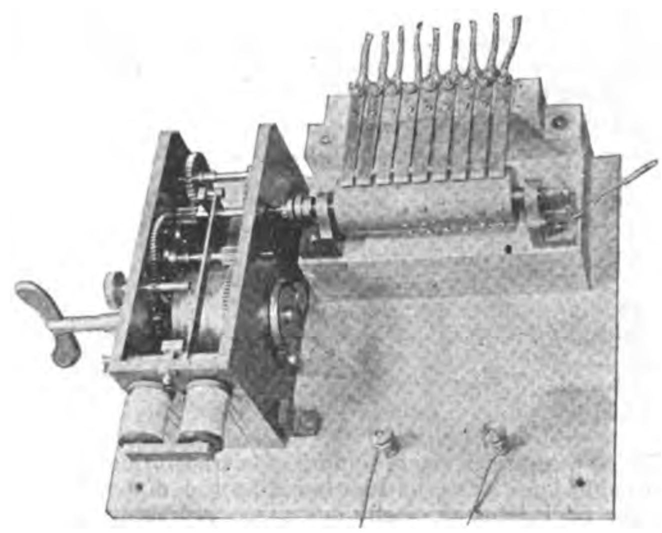


FIG. 15.—HOLLERITH INTEGRATING MACHINE.

but when they entered the tabulating machine, a dial would be energized and would operate not merely once, as in the ordinary population statistics, but would count from one to nine, according to the value of the hole, the counting being determined, as before, by the location of the hole. The device consists, broadly, in a cylinder around whose circumference studs are set; spring contact points connected to the mercury cups of the press; a motor for revolving the cylinder in conjunction with a train of ordinary registering mechanism, and a device for starting the motor so that the cylinder will make one revolution. The operation can be readily understood. A card being put in the press, the circuit is closed through a given counter to the battery, to the cylinder of the integrating device, from one of the nine contact strips of the integrator through the corresponding mercury cup uncovered by the punched hole of the card through the plunger of the pin box corresponding to that hole, and back to the counter. At the same time another circuit is closed through the magnet, when the handle is brought down, which allows the train to revolve the cylinder of the integrating device one revolution. During that revolution the circuit through the dial counter will be made and broken from one to nine times, according to the contact strip which is brought into operation. Any number of counters can thus be operated at the same time, they being connected in multiple arc. The registration thus secured gives totals from any number of different sizes or amounts, and the device, therefore, answers a most useful purpose.

XV.

Not a little skill and judgment was necessary in perfecting the mechanical details of the Hollerith electric tabulating system that has been described above, and Mr. Hollerith freely acknowledges his indebtedness for the assistance of the manufacturers who built his apparatus. To the Pratt & Whitney Co., of Hartford, Connecticut, he wisely entrusted the development and construction of the keyboard punches, and Mr. George M. Bond, the well-known expert of the concern, gave the work his direct personal supervision from first to last. The electrical apparatus is the production of the Western Electric Co., whose New York representatives, Mr. H. B. Thayer and Mr. Nickel, as well as others, took a deep interest in its refinement and perfection. Of course the work itself, which will continue at the Census Office for some time yet, is watched over by Mr. Hollerith, who is under contract to the Government to furnish the apparatus and maintain it in an efficient state. It may be added that the current for doing the work is derived from the local Edison lighting circuits in Washington, being first passed through a small set of Electrical Accumulator Co.'s cells grouped in a corner of the basement, with the usual attachments for charging in series and regrouping in multiple, as well as for making tests to see that they are up to the requirements of the daily work.

THE MEASUREMENT OF THE LOSS BY HYSTERESIS.

BY

Thos Spencer

It is necessary in the designing of a transformer that a thorough knowledge of the losses in the material used should be known, especially one which represents such a large part of the total loss as that by hysteresis. The loss from this cause varies greatly with the kind of iron used, and also has different values for different maximum inductions in the same sample of iron. Prof. Ewing, who is in a great measure the father of this subject, has given us several tables where the loss in watts per unit of volume is given for different kinds of wire for various maximum inductions, which have been very useful to the engineer. These tables were calculated by measuring the area of his celebrated hysteresis curve; for each value given in the tables one of these curves had to be plotted from a great many observations. Now what is wanted is some method which will abridge some of this work, and one which will not require such care to get accurate results.

The method I propose is based on two especially-designed electro-dynamometers, the general arrangements of which, as well as the electrical connections, are shown in the accompanying engraving. The dynamometer A has a double stationary coil of an equal number of turns, and a double suspended coil, also of an equal number of turns, rigidly connected together so that they will turn as one coil, but so arranged by means of the four mercury cups as to be electrically independent. These coils are each connected in series with one of the fixed coils; also they are connected with the two coils on the test ring P and S, which we will call the primary and secondary, having an equal number of turns.

The current which is supposed to be located at C must be an alternating current of known period and one following the sine law as nearly as possible, and should be so arranged as to be controlled by a rheostat so as to obtain the greatest possible range of readings.

The second dynamometer B has its stationary coils precisely like A, but its suspended coil is single, and through this coil the secondary current alone passes. The connections of the stationary coils can be seen from the figures. Now Maxwell has shown in his "Treatise on Electricity and Magnetism" that the energy stored in an electromagnet per unit of volume, if the magnetic force H and the magnetic induction B have the same direction, is equal to $-\frac{1}{8\pi} HB$. Now if we designate this value by E, we have for the increment of energy per unit of volume

$$d\,E = -\frac{1}{8\pi}(H\,dB + B\,dH).$$

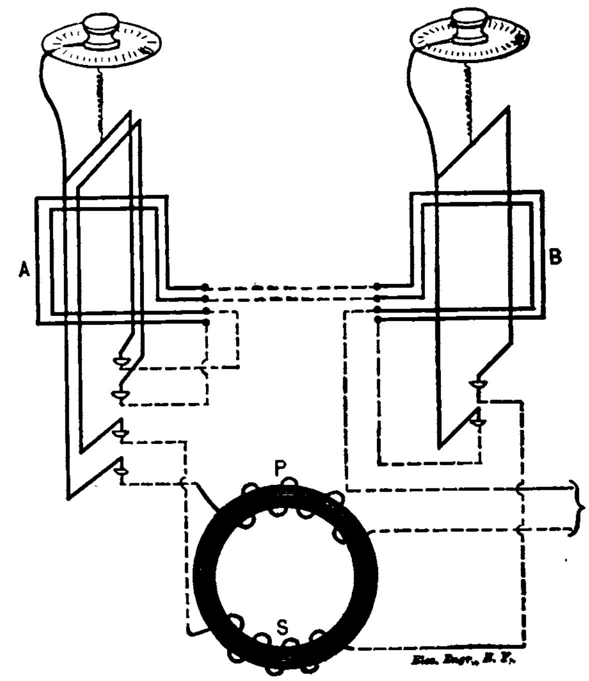
Now if we integrate this equation for Prof. Ewing's cycle, we see that

$$\int H\,dB = \int B\,dH,$$

because both stand for the area of the same closed curve, and therefore are equal to each other, and we have

$$E = -\frac{1}{4\pi}\int H\,dB.$$

Now as the current is alternating B is a function of the



ARRANGEMENT OF APPARATUS FOR THE MEASUREMENT OF THE LOSS BY HYSTERESIS.

time t, and if we represent by E^1 the loss in watts per unit of volume per unit of time, we have,

$$10^7\,E = -\frac{1}{4\pi}\int_0^1 H\frac{dB}{dt}\,dt, \qquad (1),$$

Referring again to the figure and defining the following symbols:

i_1 = Primary instantaneous current in amperes;
i_2 = Secondary instantaneous current in amperes;
N = Number of turns in the primary or secondary;
R = Resistance of secondary current in ohms;
C = Mean circumference of the test ring in centimetres;
s = Curve section of test ring in square centimetres;
α = Constant of the dynamometer A;
θ = Angle through which the torsion head is turned in A;
α^1 = Constant of the dynamometer B;
θ^1 = Angle through which the torsion head of B is turned.

Now we have for the dynamometer B,

$$\int_0^1 (i_1 + i_2)\,i_2\,dt = \alpha\,\theta. \qquad (2)$$

But we also know that

$$\frac{4\ \pi\ s\ N}{10\ C}\ (i_1 + i_2) = H, \tag{3}$$

remembering, of course, that H and B stand for the instantaneous values of these quantities.

Also we have, assuming that the secondary has no self-induction,

$$10^8\ R\ i_2 = S\ N\ \frac{dB}{dt},$$

substituting these two equations in (2) we have

$$\frac{1}{4\ \pi}\int_0^1 H\ \frac{dB}{dt}\ dt = \frac{10^7\ R\ \alpha}{C}\ \theta.$$

Comparing this with equation (1) we see that

$$-E^1 = \frac{\alpha\ R}{C}\ \theta. \tag{4}$$

For the dynamometer A, we have

$$\int_0^1 (i_1 + i_2)^2\ dt = \alpha^1\ \theta^1;$$

that is, by (3),

$$\left(\frac{10\ C}{4\ \pi\ S\ N}\right)^2 \int_0^1 H^2\ dt = \alpha^1\ \theta^1.$$

But assuming that H is a simple periodic function of the time whose maximum value is H^1, we have

$$H^2 = 4\left(\frac{\pi\ N}{10\ C}\right)^2\ \alpha^1\ \theta^1, \tag{5}$$

Equations (4) and (5) furnish us (ignoring the minus sign of E^1 in (4), a means with these special forms of dynamometers of finding the hysteresis loss for any given magnetizing force.

It can be easily seen that as i_1 and i_2 have phases differing by 180°, that $i_1 + i_2$ is very small in comparison to i_1 or i_2. So it is advisable to use as little iron (which, of course, must be laminated) as consistent with good results, and also to take the precaution to make the dynamometers with as large a current capacity as can be done without much reducing their sensitiveness.

ELECTRIC ANNEALING OF STEEL WIRE.

The electric current has been utilized since 1889 at the small arms factory at Saint-Etienne for annealing the steel wire of which the hammer springs of the rifle, 1886 pattern, are made. These springs are manufactured of steel wire, 7 millimetres thick, cut in lengths of 3.20 metres; the wire is rolled spirally, and a current of 23 amperes is passed through it. Heating is rapidly effected; when it is judged sufficient, the circuit is opened, and the hammer-spring is dropped into a water-tank. One man can anneal 20 springs in three minutes, equivalent to about 2,400 per day. Electric annealing being clean in operation, and cheap, will, no doubt, soon be applied in numerous cases analogous to the one indicated.

A NON-ELECTRIC INCANDESCENT PLATINUM LIGHT.

In a note in the *Comptes Rendus* of September 14th, M. Paquelin describes an incandescent platinum light devised by him. The apparatus consists of a strip of platinum coiled on itself and placed in a platinum bowl with a hollow stem. A gaseous mixture of air and some hydrocarbon vapor is then introduced under pressure in suitable proportions. The mixture is set alight, the flame disappears, and the platinum strip incandesces, the incandescence being the more intense the greater the pressure. With moderate pressures the light is comparable with that emitted by an electric lamp. The whole apparatus can be plunged into water without the light being extinguished.

SMALL ELECTRIC LIGHTING PLANTS FOR RESIDENCES.

BY

H. C. Dodge

There is a public want in the line of electric lighting that does not seem to have been fully met as yet, though it is a very simple matter. There are a great many dwellings and other buildings in cities, even where there is an electric light plant, in which the lights cannot be used because of the failure of the company to extend its wires anywhere except along the business streets and in a few of the more densely settled residence streets. Besides these, there are thousands of suburban residences, stables, shops, etc., in which people would like to use incandescent lights, if they could have them at a reasonable rate.

I have seen some indefinite statements floating about from time to time in the press, like clouds in the air, that where gas exists the electric light can be produced as cheaply, or even more so, than by using the gas direct, the idea being to use the gas in a gas-engine to drive a dynamo, and thus produce the electric light. Now, as gas can be had in all cities and large towns, and as by the use of portable gas machines it can be furnished in any suburban or country house, if the above statement is reliable, there is no longer any reason why everybody who desires it should not have electric lights.

But is it true? That's what the public wants to know—not by mere newspaper assertion, but by actual demonstration, with all the attendant facts and data—not theoretically on paper, but by actual tests, sufficient in extent to settle the question beyond doubt, that the public may have reliable information on which it can depend.

Now it has occurred to me that here is a field that some of our electrical companies can occupy to advantage. It would be an easy matter for them to conduct a series of experiments and ascertain exactly and fully just what can be done in that line. What is wanted is a complete plant for, say, from fifteen to fifty incandescent lamps. It should include the gas-engine, the dynamo, and the necessary shafting and belts, all ready to set up and run. The cost of the average quantity of wire and lamps, and the cost of putting them in, the companies know now, near enough for all practical purposes. If some company will take this matter in hand, conduct the necessary experiments, give the public the facts, keeping well within bounds as to the actual facts and cost, and then make a specialty of manufacturing and setting up such plants, I think a large trade could soon be built up. Not only that, but very many would want small motors for operating fans in hot weather, and for many other purposes. Of course, the apparatus should be of the simplest and most durable construction, more especially as in most cases they would be run by persons who are not skilled engineers.

It may be that this ground has all been gone over, and that such plants are already on the market, but if so, I am not aware of it.

In many cases where but few lights are required, wind wheels may be substituted for the gas-engine, but in that case a storage battery would of course be necessary, and hence the statement should include these also, with full data not only as to first cost, but as to how long they can be used effectively, cost of renewal, etc.

While the first cost of fitting up would of course be more than with gas lights, still there are many persons who would be willing to pay a reasonable additional amount because of the many advantages of the electric light.

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EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, *150 Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. XII. NEW YORK, NOVEMBER 11, 1891. No. 184.

The thread which was spun in darkness by those who sought a perpetual motion has conducted us to a universal law of nature, which radiates light into the distant nights of the beginning and the end of the history of the universe.—Helmholtz.

THE COLUMBIAN ELECTRICAL CONGRESS.

MR. J. Allan Hornsby, secretary of the Chicago World's Fair Department of Electricity, has just returned to this country, after a visit to Europe made specially with the object of studying the Exhibition at Frankfort, arousing interest in our own fair among the electrical manufacturers of England and the Continent, and of ascertaining the prospects of the Electrical Congress that is to be held in Chicago in 1893.

The report presented by Mr. Hornsby to Director-General Davis gives an excellent idea of the main features of the display at Frankfort, and is deservedly complimentary to the taste and skill shown in making the various exhibits. But the chief interest of this part of the report lies in the statements made as to the prospects of exhibits being made at Chicago by foreign houses. Mr. Hornsby is able to report that England will be represented by Siemens Bros., the Crompton Co., Mather & Platt, and Woodhouse & Rawson; Germany, by Siemens & Halske, Schuckert & Co., W. Lahmeyer & Co., O. L. Kummer & Co,. Helios Co., of Cologne; the Maschinen-Actien-Gesellschaft and the Allgemeine Elektricitäts-Gesellschaft; Switzerland, by the Oerlikon Works and Alioth & Co.; Belgium, by the Société l' Électrique and the Société Le Phenix, of Ghent; Austria, by Ganz & Co.; France, by Victor Popp & Co., Sautter, Harle & Co., Carpentier & Co., and Breguet & Co. To these may be added a number of makers of miscellaneous apparatus, and we have no doubt that the efforts of the European Commissioners who have now visited this country will lead to a great increase in applications for space.

What Mr. Hornsby says about the Electrical Congress is quite important. After seeing several of the leading electricians and electrical engineers of Europe, he says: "In arranging for such a congress as these men deem it necessary to have, they think the United States Government ought to father the invitations and that it ought to be held under Government auspices; that invitations ought to be issued to individual scientific men of the world by the United States Government through the government to which the individuals belong. This course of action, the gentlemen say, will insure an official character to the proceedings of the scientific congress, and will virtually pledge the various governments to a recognition and adoption of the standards created." This line of action, it is urged, will secure the co-operation of men without whom the congress would fall flat and fail of its purpose. Mr. Hornsby has put the case none too plainly, and we believe with him that success will be reached in just this way. It was thus that the last Electrical Congress was held in this country—that of 1884—and very much the same policy should be pursued now that was adopted then. The principal difference between then and now is that, while electricity at that time was largely a theoretical science without any representative organization, there is now a great electrical engineering profession which finds its exponent in the American Institute of Electrical Engineers.

CENSUS-TAKING BY ELECTRICITY.

OUR pages contain this week a description of the manner in which the Census of 1890 has been counted by the ingenious Hollerith electric tabulating machine. None but they who have seen the apparatus can realize the ease and accuracy with which it performs its task, dealing with the utmost facility with the most complicated combinations of statistical data. It will be remembered that in various quarters no little fault has been found with the census taken under the supervision of Mr. Porter. Possibly these criticisms may be well based so far as the selection of the local enumerators is concerned, and possibly all these enumerators did not perform their duty as well as might have been wished, but when it comes to the counting inside the Census Office, all we have to say is that we do not believe it could be better done than in the manner devised by Mr. Herman Hollerith. And this is said with the more emphasis because some of the bitter articles in the daily papers have been enough to lead one to think that, after all, the political bias shown in them might be justified by shortcomings in the methods adopted and in the failure of electricity to execute the great task laid upon it. So far from proving inadequate, the Hollerith system has more than fulfilled its promise, and in one important department alone effected a saving of 40 per cent. above the estimate of the expert commission that recommended its adoption.

Now that census authorities have had such admirable apparatus placed at their disposal, it is to be hoped that a permanent Census Bureau may be established, and a permanent staff be formed. The necessity of such a bureau is seen when men like Gen. Walker and Col. Carroll D. Wright join hands with Mr. Porter in efforts to secure it. It is painful to reflect that, in spite of the money and pains spent on the Census of 1880, the elementary information obtained by it as to the number of married and single people has never been elicited! Electrical people have lately had an experience of this kind in the starting out to secure electrical data and then the proposal to let the work drop to the ground because time and money were wanting. It seems to us that it would be nothing more than fair if part of the money saved by the Hollerith electric tabulating system were devoted to the perfection of the electrical census, giving us for the first time in history trustworthy figures as to the industry; and that the remainder were spent in founding a permanent bureau which shall give every industry and society at large, at all times, the data and statistics which, if rightly collected and interpreted, must be at the basis of all successful work and all intelligent advance.

THE ELECTRIC LIGHTING OF SUBURBAN RESIDENCES.

While the manufacture of small dynamos for isolated plants has been undertaken extensively by several electric companies both here and abroad, the suggestions of Mr. W. C. Dodge, which appear on another page, are novel in that they contemplate the combination of a small gas engine, requiring no expert attendance, and a dynamo of just sufficient capacity to supply the house, stable or shop in which it is placed. It would be both interesting and instructive to know just how economically such a plant could be operated. Mr. Dodge's windmill idea hardly seems feasible in this latitude, although such a combination might be advantageously operated in the region of the Trade Winds. The pros and cons of the matter, however, we leave to the reader, with the hope that the data asked for by Mr. Dodge may be forthcoming. Some of the gas engine isolated plants are said to make an excellent showing.

OVERHEAD ELECTRIC RAILWAY CONTACTS HERE AND ABROAD.

The earliest electric railways employing the rails as conductors and operating at low potentials naturally required a firm and positive contact, and the brush or sliding contact was applied for that purpose with good results. When the construction of overhead railway conductors was inaugurated a differentiation was developed in the practice of American and European—especially German—constructors. While Americans at once adopted the trolley wheel and have continued its use and are likely to retain it indefinitely, the Germans began with the sliding contact and appear still to favor this form. The Siemens & Halske electric road, at Frankfort-Offenbach, built in 1884, it will be remembered, was equipped with a slotted tube-conductor with internal slider, and is still in operation. Notwithstanding the extended and successful application of the trolley wheel on American railways since that time, Siemens & Halske still adhere to the sliding contact as exemplified in the road recently operated in connection with the Frankfort Exhibition. The illustration of the method of obtaining contact, which we give in another column, would hardly seem to bear out the statement that our methods, in this respect at least, are crude and unsightly. From an æsthetic point of view, the graceful trolley-pole is certainly to be preferred to the latticed support and wire-frame contact device. Aside from this point of appearance, however, we believe the sliding contact in general to be an unnecessary refinement, and that where one trolley wheel is insufficient to carry the current without undue overheating, a double trolley wheel will answer the purpose completely. The old overrunning trolleys were double-wheeled, but chiefly with the object of keeping them on the wire.

The Southwick Cookery School.

At the time of the recent electrical executions in this State, with their details of the manner in which the bodies of the criminals were affected by the current, a few remarks were made in these columns as to the features of the baking and boiling that were part of the operation. Our comments were satirical, or meant that way, but we now find that Dr. Southwick really intends to establish a cookery school so that he may learn how to do condemned men to a turn. His own language is: "The tendency of the electric current to hesitate in its flow through the human body and to develop arcs on the surface and so make the flesh boil or burn is what I am trying to overcome. Electricians have insisted that in this I shall not be successful, but I believe they are wrong." This is rather amusing, to say the least, in view of the strenuous denials that the bodies of the men executed were damaged or mutilated. It is stated by the *Buffalo Commercial* that Dr. Southwick has been experimenting with raw beef and now proposes to try conclusions with a calf. We are not aware as to the number of men and "lower" animals yet submitted to gerricide, but so far the lower animals have had much the worst of it, in the proportion perhaps of four to one. Hanging is at least preferable on the ground that when a murderer is strung up it is not necessary to hang half a dozen cows and horses with him to make sure he is dead.

The Measurement of Hysteresis.

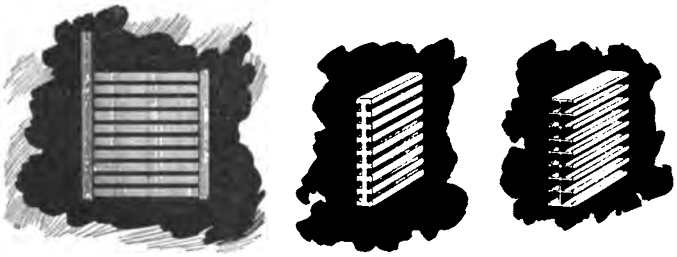
The importance of taking into account the work absorbed in overcoming the hysteresis in iron used in the construction of alternating-current machinery is too obvious to require further comment, but the actual methods employed have involved difficulties which may have deterred many from undertaking these important tests. The method described by Mr. T. Spencer in this issue, although involving two electro-dynamometers, is quite simple and, taken in connection with Mr. C. Steinmetz's work, which has appeared in our columns, affords an opportunity of determining and applying the results with the least expenditure of time.

THE ACCUMULATORS AT THE FRANKFORT ELECTRICAL EXHIBITION.—III.

BY

Dr Paul Schoop

THE most original exhibits are those of the firm of De Khotinsky, of Rotterdam. The lead supports for the paste, or active material, are not grids, and are not made by casting, but consist of lead strips made by pressing lead through a die. The mode of manufacture is the same as that of the



FIGS. 14, 15 AND 16.

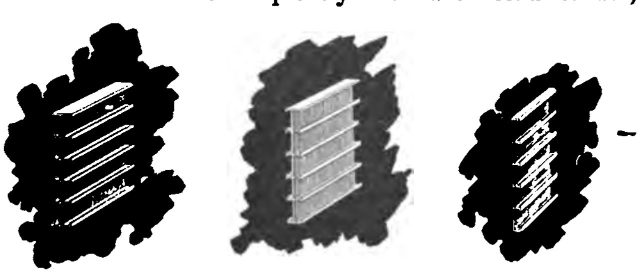
old Tudor plate. These strips are connected in two different ways. In the old way of connection the strips were laid horizontally in flat earthenware vessels, separated by glass rods. The new mode of connection consists in forming vertical plates out of such strips, as shown by Fig. 14. The strips are laid beneath each other, leaving a small distance between for expansion, and soldered or cast together at both ends by cross-bars. A number of such plates are then combined to form a positive or negative section in the same way as done with the old E. P. S. cells. Fig. 15 shows piece of strip for positive (oxidized) plates of long life and great durability.

Fig. 16 is a lead support for negative (lead-sponge) plates, as commonly used for batteries for all kinds of work.

Fig. 17 is a support for positive (oxidized) plates for the same purpose.

Fig. 18 is intended for positive plates for high rates of charge and discharge.

Fig. 19 is intended for negative plates for high rates of currents in charging and discharging; this special sketch shows an end plate. The strip is provided only on one side with ribs and consequently also with lead oxides,



FIGS. 17, 18 AND 19.

while the other side having no opposite positive plate, remains idle.

No doubt the Khotinsky lead strips do not cost half as much labor as cast lead-plates do, but only comparatively small strips can be easily obtained, and these have to be soldered together to form a plate.

Mr. Ch. Pollak, of Paris, has gone a step farther in this direction and makes lead sheets suitable for lead-oxides in the cheapest possible manner. Sheet-lead of, say, $\frac{1}{8}$ to $\frac{1}{4}$ inch thickness is passed through rollers of most ingenious construction, and so provided with numerous corrugations. After the sheets are cut into suitable shape they may be filled with paste and built up into elements. This mode of manufacture allows quite new and original departures from the accustomed methods of construction. Fig. 20 shows a front view of a piece of Pollak plate. With the Pollak plates the cost of the mechanical part of a cell ought to be reduced considerably. Fig. 21 shows the projection enlarged.

While all the described systems of batteries are only exhibited at Frankfort in regard to lighting purposes, we may now consider more closely the exhibits of the Oerlikon works, near Zürich, which are to demonstrate the practicability of storage batteries for driving electric launches, street car work, and the lighting of railway coaches; in short, for all cases where a battery is not always standing at the same place. It has ever been a difficult task to move whole batteries without spilling the acid. We must remember that such transportable cells must evidently not be provided with hermetically sealed covers since the development of gas bubbles has to be taken into account. The breaking of *one* jar or vessel is sufficient to destroy the insulation of the whole plant, and to necessitate expensive repairs and give trouble. This is also true of primary batteries.

Now, with the Oerlikon batteries the use of pure dilute sulphuric acid as an electrolyte is abandoned, and instead, a stiff, thick, gelatinous mass is applied to them. According to information contained in the price-lists of the Works, this gelatinous mass is obtained as follows:

Dilute sulphuric acid is mixed with the proper amount of a solution of silicate of soda or silicate of potassium

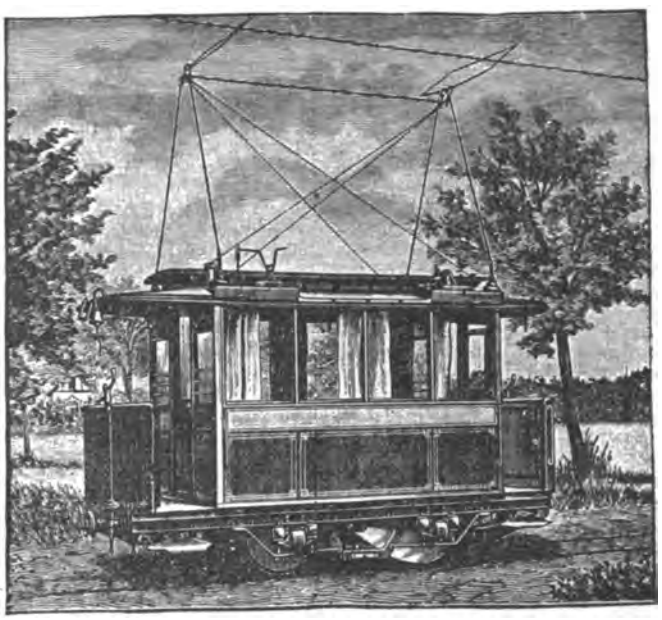
FIGS. 20 AND 21.

and some asbestos fibre. This mixture, at first fluid, becomes stiff after a short time, and is filled into the vessels containing the lead electrodes in the same way as has always been done with the pure dilute sulphuric acid. A cell filled thus may, after some hours, safely be reversed, holding the top of the cell downwards without spilling a single drop. But even this is not the best part of it. According to the use and destination of the cells, the dilute acid may be gelatinized in such a manner that the falling out of the active material from positive or negative electrodes is impossible. This seems very practical indeed at first sight, but how, if such a battery is overcharged occasionally, shall the gas bubbles find their way out of this stiff gelatine? This question is soon solved by observing the cells towards the end of charging; a lot of gas is evolved and escapes *between* the lead-plate and the stiff, but plastic, electrolyte. A split is formed, if large gas bubbles are escaping along the surface of the electrode, and as soon as the gas has escaped the gelatine again adheres to the plate. The manufacturers of this gelatinized battery claim a number of advantages for it, of which we may mention greater reliability, as short-circuits in the interior of the cell are impossible; more work per unit of weight (very heavy currents for charging or discharging) without subsequent rapid deterioration of the plates, because the gelatine not only causes a better distribution of the current all over the surface of the plates, but also allows this departure in the manufacture of the electrodes, and that the material to become active may be applied to the grids in as porous a state as desirable for such purpose.

THE SIEMENS AND HALSKE OVERHEAD SYSTEM AT LICHTERFELDE.

The London *Electrician* of Oct. 23 contains an article on the Siemens and Halske overhead system in operation at the Frankfort Electrical Exhibition, from which we reproduce the accompanying illustration, and quote as follows:

"The chief feature about the line is undoubtedly the simple and convenient system hit upon for making the contact with the overhead wires. Contact is made by means of a steel arm of T shape. The breadth of the arm is about the same as that of the tram, and the arrangement has a very neat appearance. The tram runs with the upper part of the arm lagging a little behind and pressing up on to the wire. When the tram reaches a terminus, the arm will therefore be leaning towards the direction in which the tram is going next; and at starting, the friction against the wire tends to keep the arm back, and the car gliding under the arm, forces the wire upwards for a moment until the arm is in the right direction for the return journey. The arm is kept pressed against the wire by the action of two spiral springs fixed on the axis of the T-piece, and also by the weight of the rod frame, the centre of gravity of which is below the horizontal axis. The arm occasionally jumps for an instant away from the wire at the joints. But, as the greatest current used is not more than 40 amperes, the sparking is not very formidable, and could have



Siemens and Halske Overhead System.

been cured almost entirely by the use of two arms such as were used on the cars made by this firm for the tramway at Lichterfelde, an illustration of one of which is given. The arms in this case, however, though similar in principle, are of a different and perhaps less elegant form.

It may possibly be thought that the contact cross-bar of the arm here described would soon wear away; but this has not been found to be the case. It is found that sidings do not offer the least trouble as far as the overhead contact is concerned."

HOLLYWELL'S ELECTRIC WELL.

A dispatch from Minneapolis of Nov. 2 gives the following account of a startling discovery. Now that natural gas wells are drying up, these new electric wells will come in very handily: "Charles J. Hollywell, who owns a farm near Red Wing, claims to have discovered what may be called an electrical well. Some weeks ago he employed two professional well diggers to drill a well. They had gone about 150 feet when they lost their drill rods and a diamond drill. The whole business had dropped to nowhere in an instant. There was quite a force of air coming out of the hole, and the men said there was no use going any further, because there wasn't any bottom. They concluded to fish for the rods and drill, but as soon as the rods were dropped into the hole they began to shiver in a queer way. One of the men took hold of the bar with a pair of leather gloves, and he was knocked down. Then Hollywell touched the rope and got a shock because it was wet. There seems to be a perfect natural storehouse of electricity. It is generated in some way in that pocket where the drills went, and there is enough of it to execute a whole county at once under the New York law."

Reports of Companies.

FORT WAYNE ELECTRIC CO.

The Fort Wayne Electric Company offers stockholders the right to subscribe to 80,000 shares of Fort Wayne trust securities, series A, at $6.50 per share, in proportion of 1 share to every 2 shares of Fort Wayne stock held. Rights expire Nov. 10; those not taken will be sold by public auction Nov. 11. The company has received an offer at subscription price for all stock not taken Nov. 12. The company has transferred to the American Loan and Trust Company as trustee a little over $800,000 of mortgage bonds, bearing 5 and 6 per cent. interest, and about $700,000 of stocks of various companies, acquired in the natural course of its business. It is expected that after the first 90 days of the operation of the trust the trustee will be able to disburse quarterly dividends at a rate of 12 to 15 cents per share.

Appointments, Etc.

Mr. B. J. Jones has been appointed general superintendent of the Riverside Park Railway Co., of Sioux City, Ia., vice C. W. Rickard, resigned, taking effect November 1.

Mr. R. J. Sherrill has resigned his position as superintendent of the Asheville, N. C., Light & Power Co., and has entered the service of the Edison Electric Co., at Schenectady, N. Y.

Mr. J. Knapp Ford has been appointed electrician and superintendent in charge of the West Troy, N.Y., electric light plant to succeed Wm. Waldron, resigned.

Mr. L. K. Perot, lately of the Thomson-Houston Co., has been appointed assistant engineer of the Equitable Engineering & Construction Co.

Mr. Irving W. Blake, of the Perkins Lamp Co., of Manchester, has joined the forces of the Mather Electric Light Co., in Chicago.

Mr. H. D. Halstead has been installed as electrician of the electric light plant at Milford, Mass.

Mr. Fred. Young has been appointed superintendent of the Willimantic, Conn., Electric Light Co.

THE PROPOSED PACIFIC CABLE.

The United States Fish Commissioners' steamer Albatross, which has been taking soundings in connection with the laying of the proposed cable between the United States and Hawaiian Islands, has returned to San Francisco. Silinas Landing, in Monterey Bay, is regarded as the most suitable landing place for the United States end of the cable.

Legal Notes.

STORAGE BATTERY PATENTS—JULIEN vs. ELECTRICAL ACCUMULATOR CO.

When the decision was given in the United States Circuit Court by Judge Coxe granting a permanent injunction against the Julien Electric Company from infringing the patents of the Electric Accumulator Company in using storage batteries on street cars and in other places, the defendants asked for a re-opening of the case on the ground that a Spanish patent of the Accumulator Company, by expiring, had invalidated their patents in this country. The Accumulator people said that it was a different patent. Judge Coxe decided on November 4, that the injunction must stand.

THE RANKIN KENNEDY ALTERNATING PATENTS.

The Marble City Electric Light Co., of Rutland, Vt., has filed its answer in the suit recently brought against it by the Westinghouse Company, alleging infringement of the patent of Rankin Kennedy for method of electrical distribution by transformers connected in parallel. The answer is in effect a general denial both of the validity of the patent, and of the allegation of infringement. In addition to numerous prior patents and publications, prior knowledge and use of the inventions is alleged on the part of W. K. Freeman, M. M. M. Slattery, T. A. Edison, Elihu Thomson, W. Stanley, Jr., R. M. Hunter, E. E. Ries and others.

OVERHEAD RAILWAY CIRCUITS—THOMSON-HOUSTON vs. ELECTRIC MERCHANDISE CO.

THE Thomson-Houston Electric Company last week began suit in the United States Court against the Electric Merchandise Company, of Chicago, to enjoin an alleged infringement of patents for overhead conductors and switches for electric railways. An injunction restraining the use and manufacture of the devices is asked.

Personal.

MR. WILLIAM DIERMAN, C. E., of Belgium, is now in this country, having been specially commissioned by the Belgian Government to make inquiry into the condition of the electrical industries of America. Mr. Dierman, during his stay of two months, will investigate the leading light and power systems, and visit various roads and plants, etc. Mr. Dierman, it is interesting to mention, is a graduate of the Montefiore Institute in Liege, among other seats of learning in Belgium and France, and enjoyed the instruction of Prof. Eric Gérard, so well known here and abroad in electrical science. Mr. Dierman is now in the active practice of his profession as a civil and electrical engineer, and will, when he leaves, be able to make a comprehensive and valuable report.

Letters to the Editor.

NOTE ON THREE-PHASE ALTERNATING-CURRENT MOTORS.

IN view of the marked interest which is now being taken in the three-phase alternate current motor, I would call attention to the fact that on looking over some old correspondence I find a letter written to me by Dr. Louis Duncan, of Johns Hopkins University, November 1, 1888, in which the following occurs:

"Do you know how the Tesla motor works? How does this strike you for a modification to be used with an ordinary alternating circuit?" [Here follows a diagrammatic figure of the field magnet of an alternate-current motor].

The letter then goes on to say: "What we want is a rotating field of force. Take a set of magnets, 1, 2, 3 (1', 2', 3', are the opposite sides); bring the main circuit to 1 and take it around 1 and 1'; then back. Then make the circuit of 2 and 2' around 1 and also 2, inducing in it a current of different phase from 1; make 3 a secondary of 2; adjusting the self-inductions and *R*'s so that the difference of phase in each is 60° at, say, full load. We have a rotating field as Tesla has, and can put in a closed circuit armature and get the same results. But I am doubtful if the relation of the phases of 1, 2 and 3 will be even approximately constant at different loads."

FRANK J. SPRAGUE.

NEW YORK, Nov. 6, 1891.

THE EDISON ELECTRIC RAILWAY SCARE.

IN your issue of the 4th inst. I find under "Letters to the Editor" an article headed "The Effect of Newspaper Inventions," as also your editorial on the same.

As one interested in electric railway construction in all its branches from the rail to the trolley wire, I would ask your indulgence and consideration wherein I differ from your views of the "effect of newspaper inventions." While you very kindly try to find an excuse for Mr. Edison, and say that "it is hardly fair to hold Mr. Edison responsible for the exaggerations and bulls crowded into these reports," the excuse is hardly well taken when it is currently reported that the articles are paid for and distributed throughout the country by the Edison General Company.

Your editorial goes on to say "if this talk arrests development the Edison General Company will suffer with the rest." Why, may I ask, should the "rest" be made to suffer with the Edison Co? If the machinery placed by them on the market and claimed to be superior to that invented and manufactured by them for that genius of electric railway locomotion, Frank J. Sprague, has left such superiority open to question and criticism by street railway managers, and which not even the name of the Wizard Edison attached to the same has been able to supress, why, may I ask, is it necessary for a company to use such methods, unless the reports are circulated to gain time? If this be the case, it is possibly the most natural thing they would do.

What the new system of electric railway locomotion is we are left to guess. Not even those who are familiar with the business are given any inkling of what it may be. Possibly Mr. Leo Daft, were he now in the East, could tell us something about the new system. The gullible public are ready to believe almost anything. The force of this struck the writer on perusing the New York Sunday *Herald* of recent date, where in adjoining columns we find descriptions of the work of the Wizard Keely and the Wizard Edison. It is a usual thing when well-known men make statements to the public to receive them without question, and it is considered as good as done. Unless one is deeply interested, they are not apt to follow up or remember the names and predictions of the men whose words mean either successful accomplishment of what they have predicted or the names of the men whose words and predictions are simply made use of either to manipulate stock or afford time to produce or perfect something to take the place of that which has not fulfilled the requirements called for.

I have a hazy recollection of seeing printed in newspapers articles similar to that with which the country has recently been flooded, describing the system of telegraphy from moving trains. Every train was to be fitted in such a way that we could telegraph to our friends and telegraph our business as we were whisked across the country. Similar printed statements of how we were to talk into a phonograph and do all our correspondence with little wax cylinders, revolutionizing the entire methods of conducting business and social correspondence, are still fresh to the memory of all. The dream of direct production of electricity from heat all passes before me. How successful and practical they have been the public are the judges. When men whose names are familiar to us do not carry into execution what they predict, and in doing so injure those who do, it is excusable to raise our voice in protest of such methods. You, no doubt, "see not the slightest reason why any railway project entered upon or even broached should not be carried to the conclusion," which, curiously enough, follows with this sentence, "When Mr. Edison puts his plant on the market it will be time enough to discuss its actual effect." Unfortunately you do not seem to have been in the place of a railway president or manager endeavoring to convince his board of directors and stockholders to the adoption of electric propulsion and use of present designs of motors, when these gentlemen are already skeptical and purse strings tight, without having arguments brought forth against their equipping backed up by statements of the Wizard Edison.

You seem ignorant of the fact that city councils are now opposing the passing of overhead ordinances for overhead wires, on the ground that the Wizard Edison has stated that there is no need for overhead wires. While it is impossible to reach the public with the true facts and status of the electrical business, yet it is within the province of our trade journals to assist in stopping such peculiar attempts made by one unsuccessful branch of the business to injure others which are successful. We know the power of the daily press; we also know the electrical trade press has power in its own field. Therefore, let it dare to do right and put the facts before its readers, which it may readily do by either sifting similar articles and explain the matter, or decry such methods with all the power that pen and printer's ink can supply.

REJECTED FRANCHISE.

CHICAGO, ILL., Nov. 6, 1891.

[Seeing that we expressly *deplored* the appearance of these rumors about Mr. Edison's electric railway work, we fail to see how our remarks can be twisted into "trying to find an excuse for Mr. Edison." But while *deploring* these rumors, we ventured to point out that the hopes or fears of many people had exaggerated the newspaper talk on the subject out of all proportion to its real importance. We do not know of a single electric railway project that has been abandoned because of these wild articles in the newspapers. If any have been, we would like to have the names furnished to us. As to its "being currently reported that the articles are paid for and distributed throughout the country by the Edison General Company," the "distribution" should be easily capable of proof; and we will be glad to receive the evidence and publish it. That the articles were paid for, might not be quite so easy to prove. The papers are the *New York Herald*, the *New York World*, the *New York Sun*, the *New York Evening Post*, and several others. Our readers can form their own opinion as to the "current report" that Mr. Edison bought these papers up, and further, as to whether the electrical press is also carried in Mr. Edison's vest pocket. The traditions and record of THE ELECTRICAL ENGINEER should at least protect it against such insinuations. As far as we are aware, the electrical press has generally "dared do right," when it came to a question of daring. That emergency does not seem to us to attend the present situation.—EDS. E. E.].

PHOSPHORESCENCE OF GEMS.

THE phosphorescence of gems under electric discharge in a high vacuum, which Prof. Crookes exhibited at the recent soirée of the Royal Society, London, evoked much admiration. Cape diamonds phosphoresce blue; Brazilian ones, red, orange, blue and yellow; Australian ones, yellow, blue and green. Crystallized alumina, that is to say, ruby, sapphire and corundum phosphoresce a deep red, and give a spectrum of a single sharp crimson line.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED OCTOBER 20, 1891.

Alarms and Signals:—

Non-Interfering Successive Signaling System and Apparatus, F. B. Wood, 461,464. Filed Oct. 24, 1890.
Relates particularly to fire and police systems.

Signaling Apparatus, C. T. Barrett, 461,518. Filed June 5, 1891.
Designed to notify, on the cars or engine of a railroad train, the condition of switch signals.

Bell-Ringing Attachment, W. W. Slater and H. C. Barnes, 461,718. Filed May 12, 1891.

Annunciator, L. F. Fouts, 461,748. Filed June 5, 1891.

Clocks:—

Electric Clock-Winder, J. W. and C. F. Du Laney, 461,423. Filed Feb. 12, 1891.

Circuit-Closer for Clock-Winding Mechanism, J. W. Du Laney, 461,424. Filed May 18, 1891.

Conductors, Conduits and Insulators:—

Composition of Matter for Insulating Purposes, M. O. Farrar and C. C. Howe, 461,467. Filed Mar. 6, 1891.
Consists of silica, alumina, peroxide of iron, magnesia, lime, soda, potash, water and asphaltum.

Insulating-Support for Electric Conductors, R. J. Hewett, 461,631. Filed July 30, 1891.

Electrical Conduit, E. T. Greenfield, 461,677. Filed May 11, 1891.
Claim 1 follows:
A conduit having interlocking sections and covers, in combination with individual spaced ducts surrounded with an insulating mass which unites the ducts and the conduit and holds the covers in place.

Dynamos and Motors:—

Field-Magnet for Dynamo-Electric Machines, F. J. Sprague, 461,552. Filed Jan. 19, 1885.
Claim 1 follows:
In a dynamo-electric machine, the combination, with the series of longitudinal plates forming a field-magnet core, of the outer clamping plates having extended portions and the cross-brace extending from one of said extended portions to the other.

Armature for Electric Motors or Dynamos, R. Lundell, 461,795. Filed Apr. 4, 1891.
Relates to mechanical construction.

Galvanic and Thermo-Electric Batteries:—

Thermo-Electric Element, C. W. Iden, 461,437. Filed May 13, 1891.
Relates to methods of jointing and connection.

Lamps and Appurtenances:—

Spring-Cushioned or Suspended Arc Lamp, C. F. Brush, 461,420. Filed May 26, 1890.

Arc Lighting System, R. S. Dobbie, 461,569. Filed Apr. 8, 1891.
Claim 1 follows:
The combination, with a circuit, of two or more arc lamps, each lamp having a shunt coil consisting of several sections acting together and connected with a like coil or coils in the other lamp or lamps.

Electric-Arc Lamp, A. Wirsching and R. Schefbauer, 461,659. Filed Nov. 15, 1890.
Relates to regulating devices.

Incandescent Double-Key Lamp-Socket, W. J. McCutcheon, Jr., 461,706. Filed Mar. 21, 1891.

Incandescent-Lamp Filament, J. T. Marshall, 461,797. Filed Nov. 9, 1885.
Claim 1 follows:
A carbon conductor for an electric lamp, having in combination a filament, enlarged ends for said filament, each composed of two pieces, electro deposits of carbon uniting such pieces together, and electro deposits of carbon uniting said enlarged ends to said filaments.

Measurement:—

Electric Meter, A. B. Herrick, 461,575. Filed Oct. 16, 1890.
Makes a periodic record.

Metal Working:—

Adjustable Transformer, E. Thomson, 461,526. Filed Apr. 17, 1889.
A transformer specially adapted for graduating the current employed in electric welding.

Miscellaneous:—

Electric Elevator, J. E. Byrne, 461,493. Filed Dec. 2, 1890.
Relates to means of actuation and control.

Electrical Valve-Controller, J. V. Stout, 461,554. Filed Mar. 26, 1891.

Shunt-Magnet for Valve-Controllers, J. V. Stout, 461,555. Filed July 1, 1891.

Electric Switch, A. Swan, 461,456. Filed Aug. 6, 1890.

Snap-Switch, H. P. Ball, 461,560. Filed Mar. 2, 1891.

Snap-Switch, H. P. Ball, 461,561. Filed April 19, 1891.

Thermal Cut-Out, L. B. Favor, 461,570. Filed Mar. 12, 1891.

Process of Purifying Bromine, J. C. Kautz, 461,681. Filed May 8, 1889.

Electric Switch, G. R. Lean, 461,761. Filed Jan. 17, 1891.

Automatic Electric Switch, S. Bergmann, 461,791. Filed Feb. 25, 1891.

Railways and Appliances:—

Electric-Wire Connector, G. R. Scrugham, 461,452. Filed June 15, 1891.
For trolley wires.

Contact-Plow for Electric Cars, E. M. Bentley, 461,548. Filed Nov. 21, 1885.

Conduit and Conductor for Electric Railways, W. H. Knight, 461,549. Filed Apr. 29, 1887.
Claim 1 follows:
The combination, in an electric railway, of a conduit formed of the upright slot pieces united to a common base, an electric supply conductor in the conduit supported from one of the slot pieces, and a contact device bearing on the under side of the said conductor.

Electric Wire Connection, H. P. Ball, 461,562. Filed May 12, 1891.
For trolley wires.

Electrical Connecting Device, H. P. Ball, 461,563. Filed June 13, 1891.
For connecting rails of an electric railway.

Coupler for Electric Wires, J. H. Delaney, 461,568. Filed Dec. 29, 1890.
For joining electric conductors between the cars of a railway train.

Hanger for Overhead Wires, C. A. Lieb, 461,582. Filed Aug. 30, 1890.
For trolley wires.

Trolley Switch, C. E. Hudson, 461,611. Filed Jan. 13, 1891.

Control Apparatus for the Position of Signal Discs, T. Weisser, 461,657. Filed Nov. 29, 1889.
For verifying at a distance the momentary position of switches, toll-gates, railway gates, etc.

Motor for Cars, G. M. Brill, 461,662. Filed June 19, 1890.
Claim 1 follows:
In a swiveling truck for electrically propelled cars, the combination, with the frame of the truck, of the driving-wheels larger in diameter than the truck-wheels, and an electric motor, one end of which is spring-supported from the frame of the truck, and connections between the armature of the motor and the driving wheels.

Electric Railway, F. Mansfield, 461,685. Filed Nov. 18, 1890.
Improvements upon the railway patented to the same inventor July 22, 1890, Nos. 432,673, 432,674 and 432,675.

Electric Railway, S. H. Short, 461,090. Filed April 24, 1890.
A two-trolley system.
Claim 1 follows:
In combination with two supply conductors, a car or vehicle and a motor on said car for propelling the same, two independent pole trolleys or travellers on said car, comprising each its individual pole and its individual hinge, and swivel spring mounting, and each having its contact independently pressed by the said spring against one of said conductors and electrically connected with a corresponding pole of said motor.

Electric Block Signal System, J. La Burt, 461,760. Filed July 14, 1891.

Electric Railway-Brake, A. I. Ambler, 461,770. Filed Dec. 18, 1890.
Electrical control of mechanical brake.

Trolley-Wire Support, L. S. Pfouts, 461,785. Filed July 8, 1891.

Telegraphs:—

Telautograph, E. Gray, 461,470. Filed June 13, 1889.
Writing telegraph. Improvement upon the apparatus shown in the same inventor's patents of July 31, 1888, Nos. 386,814 and 386,815.

Telautograph, E. Gray, 461,473. Filed Sept. 17, 1889.
Amplification of Mr. Gray's telautograph system.

Telautograph, E. Gray, 461,474. Filed Sept. 22, 1890.
Further amplification as above; includes the employment of fluid under pressure for giving movement to the circuit closer.

Art of Telegraphy, E. Gray, 460,471. Filed July 19, 1889.
Writing telegraph. Improvements as next above.

Art of and Apparatus for Telautographic Communication, E. Gray, 461,-472. Filed Sept. 17, 1889.
Further improvements as above.

Telephones and Apparatus:

Telephone System, C. C. Gould, 461,573. Filed May 28, 1891.
Relates to switching devices.

SOME FOREIGN THOMSON-HOUSTON WATER-POWER PLANTS.

AT St. Brieux, Cotes du Nord, France, two 1,300 light Thomson-Houston alternators are driven by two Hercules turbines of the vertical type, one of 125 h. p. and the other of 150 h. p. An interesting characteristic of this plant is that the two alternators are run in multiple upon the same circuits. The distance from the central station to the centre of distribution is 8.4 miles, and the pressure employed is 2,000 volts. It is interesting to note that the wire employed to convey the current for 2,600 16 c. p. incandescent lamps 8 4 miles is in this case only .31 inch in diameter.

At Guatemala, Central America, a combined arc and incandescent plant has been operated by means of water power since 1887. A part of the plant, consisting of two A-70 1,300 light alternators, is 3¾ miles distant from the city. The dynamos are driven by a countershaft from the 21-inch Rodney Hunt turbine of 250 h. p. The remainder of the plant, comprising seven 45 light 2,000 c. p. arc dynamos and three 18 light arc dynamos, is 7½ miles away from the city, and receives its power from a 15-inch double Rodney Hunt turbine of 260 h. p.

The city of Puebla, Mexico, possesses an electric lighting plant which is in many ways remarkable. Two hundred arc lamps of 1,200 c. p. are run by four 50 light arc dynamos in a station about 18 miles from the centre of the town, where the river Atoyac furnishes power for a 200 h. p. Leffel double turbine. Each of the four circuits is about 26 miles in length, and consists of a No. 4 insulated wire. The dam and all the masonry connected with the station itself is built of fine cut stone, forming probably one of the most substantial and best built structures in Mexico. As the station is so far from the town and in the midst of a country infested with bandits, the government finds it necessary to maintain at all times a guard, consisting of seven soldiers, to protect the station from injury by marauders.

A contract recently entered into by the Thomson-Houston International Co. provides for a plant to be worked by water power in the town of Piracicaba, San Paolo, Brazil. The system will probably comprise 50 arc lamps of 1,200 c. p. each and about 2,000 incandescent lamps of the alternating system. In this plant the power will be situated quite close to the lighted district, at about a distance of one mile.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Advertising will not perform miracles, but it will develop a business in a very miraculous way.

A NEW CUTTER SWITCH.

A NEW departure in incandescent switches is soon to be introduced by the Cutter Electrical and Manufacturing Company, of 27 South Eleventh street, Philadelphia.

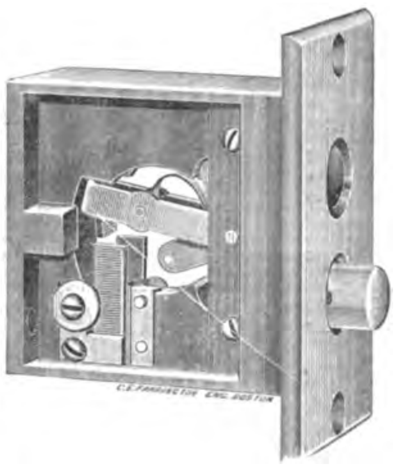


FIG. 1.—CUTTER SWITCH, OPEN.

In the subjoined illustrations, Fig. 1 shows the switch open, while Fig. 2 shows it closed. This switch is of the single-pole, double-break class, with the brushes and switching mechanism mounted upon a porcelain base, which is in turn enclosed in a casing of the same material. The copper terminal brushes are set one over the other, the distance between them being $\frac{1}{16}$ inch, the end of the switch bar acting as a bridge between them when the switch is closed, and giving a break of $\frac{1}{4}$ inch on each side when open, or an actual break of $\frac{1}{2}$ inch. The switch-bar is operated entirely by a flat semi-elliptical spring, which acts eccentrically in such manner that, until the switching lever brings the spring to centre, there is no movement whatever of the switch-bar; consequently, when it is moved past the centre, the full tension of the spring is brought to bear for the break, which is absolutely instantaneous, so that with ten amperes

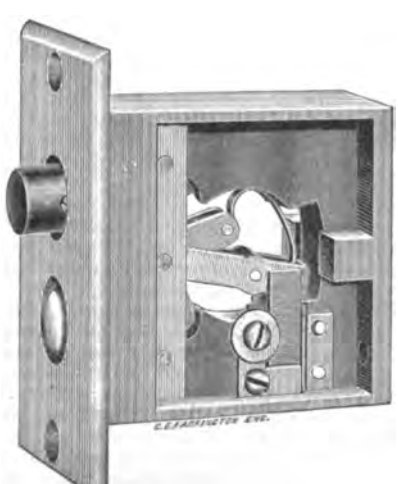


FIG. 2.—CUTTER SWITCH, CLOSED.

current this size of switch exhibits but the faintest indication of a spark.

The working parts are of hard brass plate put together in a substantial and workmanlike manner, and the mechanical and electrical construction is exceptionally good. But perhaps the most taking feature of the device is the fact that it is operated by two push buttons in a face plate, which is set in place flush with the wall or surface of the switchboard, the porcelain case containing the switch mechanism being recessed into the wall, so that nothing is presented to view but the face plate, which may be ornamented to correspond with its surroundings.

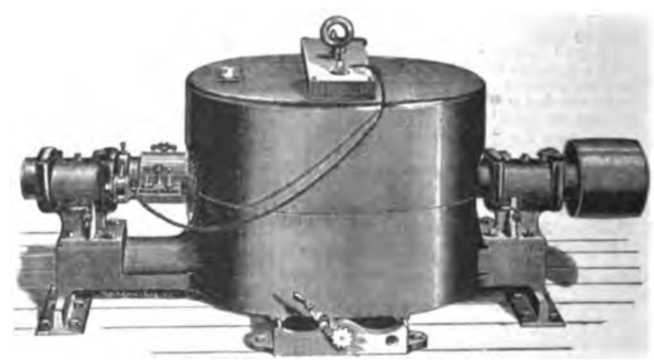
One of the push buttons is white, the other black. By pushing the white one the circuit is closed, while by pushing the black one it is opened, and in case the light governed by a particular switch is in a distant room, the condition of that light as to whether it is on or off is indicated by the relative positions of the push buttons.

The peculiar construction of this switch permits of an exceedingly convenient method of placing a number of switches in "gang" on the same face plate in a manner similar to that adopted in electric gas lighting. For instance, a gang of ten switches would exhibit only a face plate fifteen inches long by three and one quarter inches wide. The switch is also modified so as to be able to control one or more lights from two or more places.

THE MAYO IRON-CLAD MOTOR.

THE Mayo motor, made by the Rockford Electric Manufacturing Company, of Rockford, Ill., is the pioneer of the iron-clad type, the original machine of this kind having been designed by Mr. Geo. A. Mayo in September, 1884.

As will be seen in the accompanying illustration, the motor has a long armature of small diameter, of the Siemens type, and, with the field magnets and salient pole-pieces, is entirely surrounded by the cast frame, which is divided horizontally. The field coils are wound on removable shells, and slipped over the cores. The armature wires, on all motors over two h. p., are supported by Pacinotti projections, so that it is impossible for any



MAYO IRON-CLAD MOTOR.

motion to occur that might endanger the insulation. There being no free magnetism on the outside of these motors, their efficiency is said to be very high. The bearings are self-oiling and the brushes self-adjusting.

THE NEW ENGLAND WESTON ILLUMINATING CO.

THE New England Weston Illuminating Company has passed into the hands of the Boston Electric Light Company, and its real estate on Stanhope street has been deeded to the latter company. As the new owners have run the Stanhope street plant for the past four years under a lease, no change in the management takes place. The works are near the Columbus avenue station of the Boston & Albany Railroad. The purchase was made about a month ago and has just been made public. At that time the Boston company bought the Weston, not merely its property, but the concern itself. It, of course, made no difference practically in which name the realty stood, for the Weston Company had been absorbed by the larger concern. It was decided, however, to transfer the real estate.

THOMSON-HOUSTON ELECTRIC CO.

THE stock of the Thomson-Houston Electric Company has been admitted to the regular list of the Boston Stock Exchange. Par value of shares, $25. Amount of capital issued, preferred, $4,000,000; common, $6,000,000; authorized capital, preferred, $5,000,000; common, $10,000,000. H. A. Pevear, president; C. A. Coffin, vice-president and treasurer; E. Griffin, second vice-president; E. I. Garfield, secretary; directors, H. A. Pevear, C. A. Coffin, E. Griffin, J. N. Smith, B. F. Spinney, C. H. Newhall, T. J. Coolidge, Jr., S. E. Peabody, S. A. Barton.

EASTON ELECTRIC COMPANY SPECIALTIES.

The Easton Electric Company, of 647 Kent Ave., Brooklyn, are manufacturing a number of electrical apparatus peculiar to themselves, some of which are represented in the accompanying illustrations.

The Easton constant-current dynamo is shown in Fig. 1. Its chief claim to superiority lies in the construction of its various parts which are proportioned so as to provide against overheating. It is claimed that no automatic regulator is required.

The magnet coils of the dynamo are so proportioned as to be saturated by 75 per cent. of the normal current in their coils, while the armature does not become saturated with less than five times the normal current in its coils, and is also a relatively powerful magnet compared to the field coils.

While there is naturally a tendency to increase the current, when the resistance is reduced by cutting out any number of lamps, yet the field magnets do not feel the increase, because they are already saturated, whereas, the armature, not being saturated, opposes the field magnets more powerfully, and an actual reduction of voltage results. Meanwhile the current increases but very slightly, and far out of proportion to the reduction of the resistance. By this means the dynamo permits one to cut lamps in or out of circuit without affecting the dynamo injuriously. Another important characteristic of this dynamo is the fusible connection between each section of the armature and the corresponding commutator bar, intended to prevent damage to the armature from an injured or imperfect commutator. The method of mounting the armature on the shaft, shown in Fig. 2, is characteristic of the Easton dynamo, and is said to be very effective in preventing slip and securing practical ventilation.

Another peculiarity is the arrangement of the pole-pieces in such a manner that the centre of the armature is the most strongly magnetized portion, and the self-repellent property of magnetic lines of force is taken advantage of, to bring the entire core to saturation at once, thus securing the maximum of inductive action with minimum power and weight of dynamo.

The lubricating devices are automatic and reliable, and require very little attention. The brushes are small and light, are not expensive and require but little care.

The constant-potential dynamo, Fig. 3, is of the ironclad type, and is notable for its solidity and efficiency. The armatures are wound with but one layer of wire, and all sizes that have a capacity of more than 120 amperes, have but one turn per section. They are said to run with the least heating and to be sparkless. These machines are compounded, or over-compounded, to any desired extent, to compensate for the drop in line, and, it is claimed, are absolutely automatic in regulation. The bearings are self aligning and automatically lubricating, as in the constant-current Easton dynamos.

The Easton Electric Company manufacture two distinct types of arc lamps, which are designed respectively for use on currents of definite or indefinite ampereage. The one for definite ampereage, Fig. 4, is a balanced lamp, or one in which the feeding is governed by the different pulls of solenoid coils in the main circuit, and shunt off the arc, respectively. These lamps have been pronounced simple and satisfactory. They have no springs, dash-pots or other complications, and give excellent results if the current is uniform and of the proper ampereage. The lamp for indefinite ampereage has a "universal" movement, or one in which the feeding is governed by the pull of the solenoid shunt off the arc, balanced against the weight. The main coil has nothing to do with the feeding, but is only used to form the initial arc. This lamp is not quite so simple as the balanced movement, yet is claimed to be the simplest known which accomplishes the same or equal results. The universal lamp when once adjusted for any current may be placed on differing strengths of current, and will properly operate on each without adjustment.

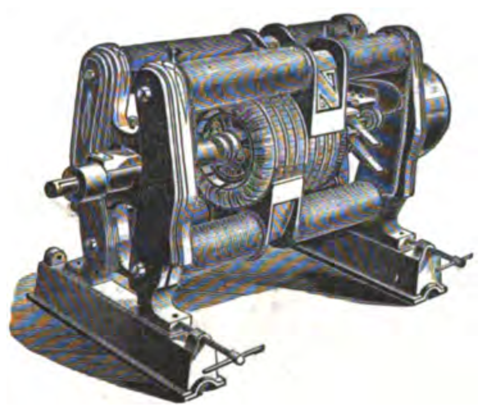


Fig. 1.

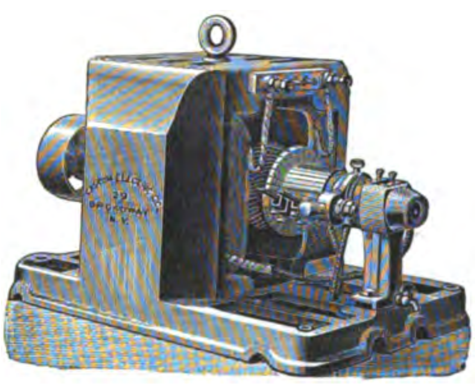


Fig. 3.

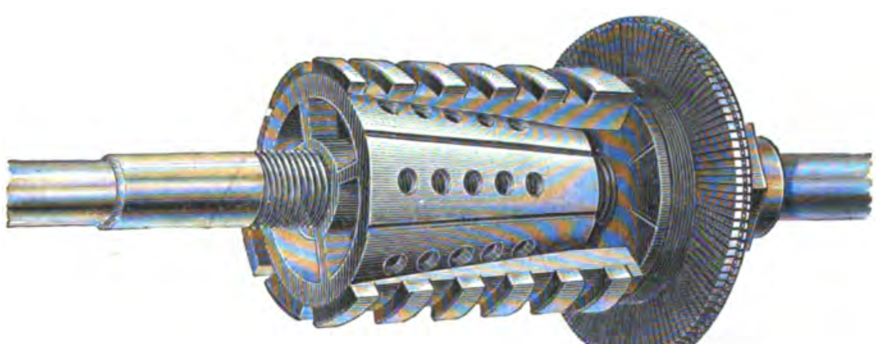


Fig. 2.

Fig. 4.

Easton Electric Company Specialties.

The "X" arc lamp is a combination of the balance movement and universal gearing, and especially adapted for use on circuits with incandescent lamps or motors. It may be operated two in series on 110 volt circuits. This type of lamp may also be placed eight in series on railway circuits of 500 volts.

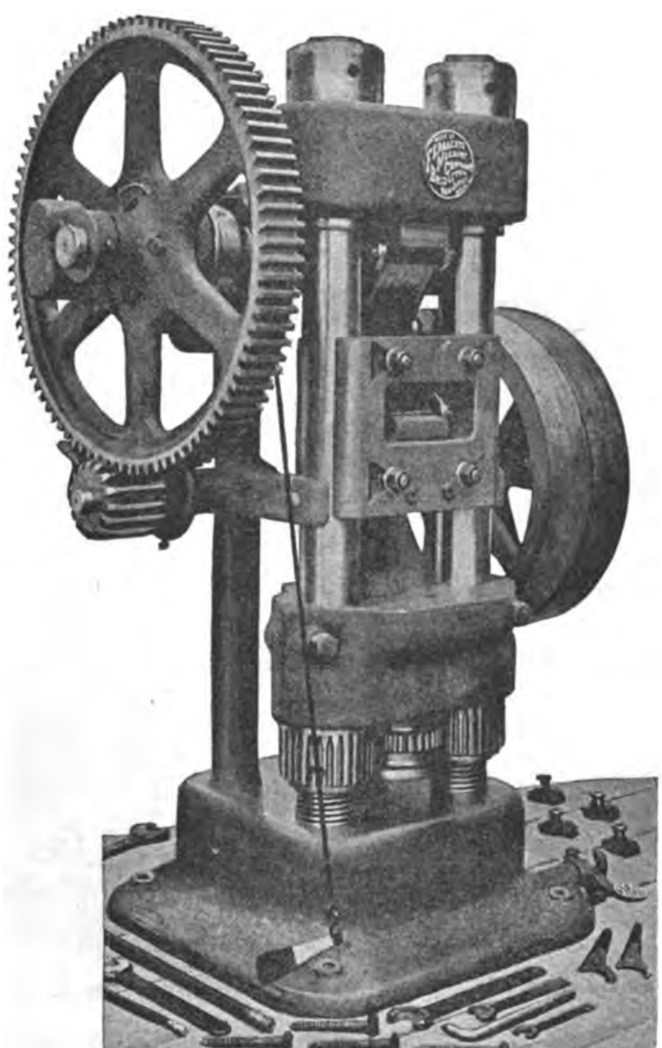
All these are single-carbon lamps, but by varying the size of the carbons they can be made to burn from six to fourteen hours. The Easton Company have been pioneers in advocating the single-carbon lamp for all-night work, and feel flattered that the ideas they have advanced and defended for many years received the endorsement of experts at the Montreal meeting of the Electric Light Association.

RIES ELECTRIC SPECIALTY CO.

The Ries Electric Specialty Co. of Baltimore, Md., reports being very busy supplying the demand for their new regulating sockets for alternating current incandescent lamps. This company is about completing an additional large plant to what they have already in operation, and in a few weeks will be ready to turn out these goods at the rate of 1,500 per day in the regulating socket department alone.

A NEW FERRACUTE COINING AND EMBOSSING PRESS.

THE Ferracute Machine Company, of Bridgeton, N. J., have introduced a new style of press for electrical work, which will be interesting to many of our readers. There are two sizes of these presses, one of which is shown in the accompanying illustration. They are designed for fine embossing and coining where a very heavy pressure is required, and for compressing and compacting any articles under six or eight inches in diameter. There are many special articles in electrical work where such presses can be used to advantage. They can also be used for cutting, forming, flattening and squeezing in a great variety of work. They are built with two solid forged steel columns to take the strains, and have an extra heavy shaft. All of the journals of the toggles, etc., are bushed with hard steel to prevent wear. They have a very long adjustment by means of the nuts underneath the bed, and a quick return motion of the slide-bar or ram. They are fitted up with cut gearing and a new form of automatic clutch, operated by the treadle. If desired, they can be built with a rim for the gear wheel and a sliding shaft, so that they can be run either with gearing, as shown, or without, for light work and quicker speed. They are built also without gearing, that is, with a heavy fly-wheel on the main shaft, arranged to engage with the automatic clutch. They can also be arranged without a clutch for continuous feeding on certain kinds of work.



NEW FERRACUTE COINING AND EMBOSSING PRESS.

Some of the dimensions of the size here illustrated are as follows: Weight, 5,500 lbs.; height from bed to slide-bar, when up, 11 inches; stroke of slide-bar, 2 inches; width between columns, 10 inches; adjustment of bed, 8 inches; speed of main shaft, 50 revolutions per minute; diameter of pulleys, 32 inches; total height of press, 80 inches; floor space, front to back, 42 inches, and right to left, 56 inches. This press will exert a pressure of about 300 tons. It is built of the best materials, and is of fine workmanship and finish.

THE ELECTRIC APPLIANCE CO.

UNDER the above name a new electrical supply house has been organized in Chicago, and will be ready for business about the middle of November. The officers of the new company are Willard W. Low, president; Harry B. Gilbert, vice-president; and Thomas I. Stacy, secretary and treasurer. Mr. Low has been well known to the Western electrical trade for the past eight years, and has a wide acquaintance among central station men and purchasers of electrical goods, and is thoroughly versed in all the details of the supply business. Mr. Gilbert and Mr. Tracey have been identified with electrical interests in Chicago for about five years, and are too well known among electrical people to need any introduction. It is the intention of the company to make a careful study of the wants of the trade, and place on the market only such goods as are in certain demand and of the highest quality. They will make a point of treating all their customers and patrons with fairness, and fill all orders, large and small, with the utmost promptness and dispatch. They have already secured control of several well-known and valuable specialties, and will be in a position before December 1 to meet every demand that can be made upon a general electrical supply house.

The new company has secured the large and well-appointed premises at 242 Madison street, which is in the heart of Chicago's retail electrical supply trade, and one of the officers will give this department his personal and undivided attention. Their facilities for carrying a large stock and making quick shipments are excellent, and their numerous friends among the electrical fraternity will wish them the fullest measure of success.

THE CUMBERLAND ELECTRIC CO.

THE Cumberland Electric Company has just been organized by the election of the following board of directors: James S. Humbird, F. S. Marr, Lloyd Lowndes, Johns McClave, Robert R. Henderson, Charles Pease and Harvey L. Chilet. Mr. James S. Humbird has been elected president, and Mr. Charles Pease vice-president and general manager. The capital stock is $100,000, and the purpose of the company will be the manufacture of electric light and railway supplies and specialties.

The company have leased the old Gephart or Paul foundry, on Front street, Cumberland, Md., for a term of years, and will immediately begin preliminaries for the erection of their plant.

THE GLOBE CARBON CO.

THE above company announce their removal to Ravenna, O. They will there have a capacity of 100,000 finished carbons per day, and will employ the most approved appliances for the manufacture of a superior article. Their simple programme is to "continue to make a carbon of long life without sacrificing any of the light." The freight rates from Ravenna are the same as from Cleveland. W. Gerrett is president; C. S. Britton is vice-president; H. E. Hayes, treasurer, and C. L. Rodman, general manager.

THE UNIVERSAL ARC LAMP.

THE Interior Conduit & Insulation Co. has acquired from the Universal Arc Lamp Co. the sole right to the manufacture and sale of the various arc lamps of that concern for use on incandescent circuits. The Interior Conduit Co. has also assumed the accounts of the Universal Co., transferring its current customers and settling outstanding bills.

TUCKER & HALL.

THE business carried on under the above title by W. H. Tucker and J. P. Hall has been dissolved. It will be continued by Mr. Tucker, at 432-434 Electrical Exchange Building, on his individual account.

PHILADELPHIA NOTES.

THE MAIN BELTING CO. have in addition to their Philadelphia and Chicago stores established a branch at 120 Pearl street, Boston, where a full stock of their Leviathan belting will be kept, and from which their growing New England trade can be supplied more promptly.

THE HEISLER ELECTRIC LIGHT CO. have just introduced their system of long-distance lighting into the towns of Kingman, Kansas, Union City and Homer, Mich.

MR. T. L. TOWNSEND, representing the Partrick & Carter Company, is sending in large orders from the West, and reports business as excellent.

NEW FREY MEASUREMENT APPARATUS.

THE E. S. Greeley & Company, have recently placed on the market a number of additions to their already large variety of standard testing apparatus The instruments referred to, and shown in the accompanying illustration, were all designed at the Greeley electrical laboratory by Mr. Charles P. Frey, electrician for the company. The chief aim in constructing these instruments has been to render them as light and portable as possible without endangering the essential features, namely, accuracy and accessibility.

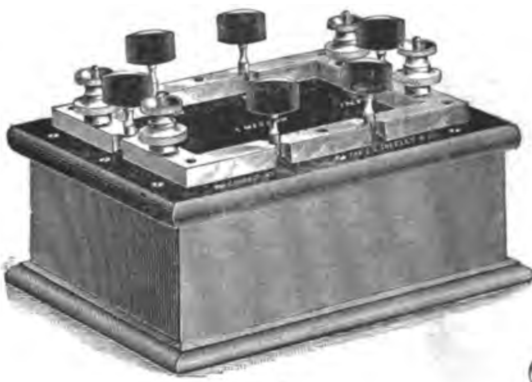


FIG. 1.

FIG. 2.

FIG. 3.

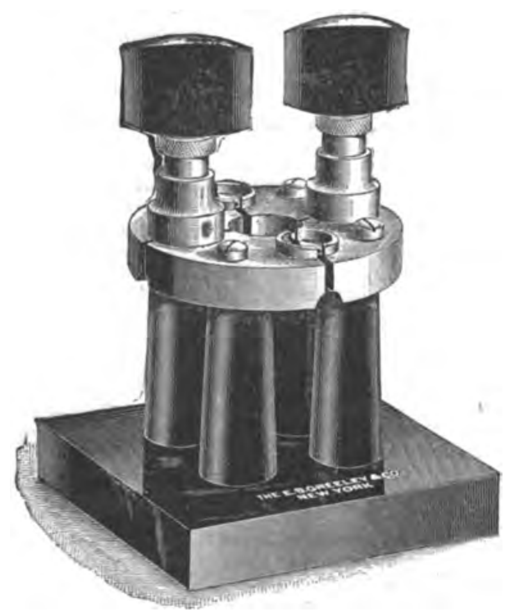


FIG. 4.

THE E. S. GREELEY & COMPANY'S NEW STANDARD MEASUREMENT APPARATUS.

Fig. 1 shows a megohm box having eight readings, embodying four readings of respectively 100,000, 200,000, 300,000, and 400, 000, ohms.

A one and one-tenth megohm box, also made by this company, has eight readings, as follows: 10,000, 20,000, 30,000, 40,000, 100,-000, 200,000, 300,000, and 400,000 ohms. Taking into consideration the large quantity of wire carried in these boxes, they are remarkably light and compact, especially since the wire is (with the exception of the four coils of 10,000, 20,000, 30,000, and 40,000 ohms) all wound on spools of 30,000 ohms each, and separately adjusted in order to secure the greatest possible accuracy.

Fig. 2 shows a four-coil Thomson reflecting galvanometer, of the Rowland type, placed on the market as a companion to the two-coil instrument of this variety, which is already well known. The Greeley Company have recently been engaged in conducting a series of elaborate and expensive experiments at their laboratory in order to determine what materials can be used to the best advantage in constructing commercial condensers for telegraphic and other purposes, with the object in view of eventually adding instruments of this type to their regular standard condensers. One of the necessary preliminary steps was to provide an improved ballistic galvanometer and some highly-insulated plug switches. Models of these were designed by Mr. Frey, and shown at the Montreal exhibit. In response to a general request, the Greeley Company have decided to regularly manufacture these instruments in the future and add them to their list.

Fig. 3 shows a cut of the ballistic galvanometer, which, although built to a certain extent on conventional lines, embodies several novel features. The casing for the mirror is provided with a hood which can be turned so that the reflection from the mirror may be observed from either side. The coils, two in number, are usually connected in multiple, but may be used independently by removing both of the coupling strips between the binding-post blocks. The coils may also be connected in series by removing but one coupling strip and giving the front coil a half turn. This galvanometer is equipped with a bell-shaped magnet, as designed by Siemens & Halske, is highly insulated, and is of superior construction and finish.

Fig. 4 shows a double-plug switch mounted on insulated pillars. The plugs are provided with caps which prevent the pillars from spreading when the plugs are inserted, and secure firm contact. A single-plug switch is also made on the same principle.

These instruments are on exhibition at the salesrooms of the E. S. Greeley & Company, Nos. 5 and 7 Dey street, New York City.

A. M. MORSE & CO.

MR. A. M. MORSE, until recently of the firm of English, Morse & Co., Kansas City, Mo., has removed to St. Louis, Mo., with offices in the Commercial Building, corner Sixth and Olive streets. During the eight years that Mr. Morse has been established in Kansas City he has gained a wide and favorable acquaintance among the steam users of the Southwest, and has designed and furnished a liberal proportion of the representative steam power plants in that section for electric lighting, electric railways, flour mills and manufacturing purposes.

The business in the future will be conducted under the style of A. M. Morse & Co., who will represent leading manufacturers of high grade steam engines, both Corliss and high-speed type, also improved boilers, steam pumps, and other specialties which go to make up complete steam power plants. They will offer only the best class of machinery at manufacturers' prices, and will make a specialty of designing and furnishing complete steam power outfits for any service, also the improvement and extension of plants already established.

LARGE ORDER FOR TURBINES.

ONE firm recently ordered eighteen large water-wheels of James Leffel & Co., Springfield, Ohio, builders of the famous James Leffel wheel. A large wood pulp mill, now under construction in Wisconsin, will use these wheels. This new enterprise is situated near large quantities of suitable timber, and where ample water-power can be obtained.

ENGINEERING EQUIPMENT CO.

By a recent enterprising move, the Engineering Equipment Co. has secured new offices and salesrooms most conveniently situated on the ground floor of the fine Central Building, 143 Liberty street, New York. The building is aptly named as to its location, being in the centre of electrical and allied interests, as well as for its connection with the New Jersey Central Railroad and its close proximity to the C. R. R. and Cortlandt street ferries. The Engineering Equipment Co. is therefore readily accessible to all buyers of steam and electric construction materials who desire to purchase directly from reliable manufacturers' representatives. The sale of cotton-leather belting is constantly on the increase. The electric railway department has been well patronized, resulting in the sale of thousands of pieces of line materials, wood and iron poles, and the furnishing of supplies for some of the largest electric railway contracts of the past year. Messrs. Perine, Tinker, Crane, Merrill and others will be happy to see their friends in their new quarters.

BURTON ELECTRIC HEATERS ON THE ESCANABA ROAD.

The following testimonial speaks well for the Burton electric heaters:

ESCANABA, MICH., October 27th, 1891.

ELECTRIC MERCHANDISE COMPANY,
11 Adams St., Chicago.

GENTLEMEN: The Burton electric heaters you sent to the Escanaba Electric Street Railway Company have been put to a good, thorough test and have been found equal to the emergency. We have had some cold weather and quite a fall of snow, but the cars have been as warm as toast. Your heaters are the simplest, cleanest, and most efficient of any heating apparatus in the market. You may use this in any manner you wish, or refer to me at any time.

Respectfully yours,
(Signed) GEORGE W. FINCH,
Electrical Engineer.

THE CHICAGO ELECTRIC MOTOR CO.

The Chicago Electric Motor Co., Springer Building, Chicago, recently received the following among other testimonials regarding their repair work, of which they make a specialty:

"GENTLEMEN: Replying to yours of the 18th inst., we can say that we are well pleased with the work done in the past two months by your Mr. J. G. Hart. He rebuilt three No. 32 Edison generators, and overhauled the general equipment of our road to our satisfaction. For general repair work on electric machinery, we are pleased to refer street railway and light station managers to your company, if first-class work and reasonable prices are desired.

"Yours truly,
"KEOKUK ELECTRIC STREET RAILWAY AND POWER CO.,
"H. C. REINER, Secretary."

JEWELL BELTING CO.

We have received from the Jewell Belting Co. two very tastefully bound copies of their pamphlets on the "Jewell Dynamo Belt" and "Transmission of Power by Leather Belting." These brochures describe the interesting process of making the belt, show cuts of details handled by the company, such as hooks, laces, fasteners, etc., views of tanneries, etc., and give a variety of most useful tables and data. The tables of transmission of power will be serviceable to every engineer, while there are a good many points of interest in the various records cited in detail as to sizes to pulley and belt, amount of power transmitted, life of belt, etc.

RIES ELECTRIC SPECIALTY COMPANY.

MR. ELIAS RIES, president of the Ries Electric Specialty Co., of Baltimore, Md., was a visitor to New York last week. Mr. Ries reports that his company is putting in new machinery as fast as possible to facilitate the rapid manufacture of the sockets. His company is now in a position to furnish regulating sockets for any kind of base, and a sharp increase of business is already noticeable.

BROWN, BOVERI & CO.

MR. C. E. L. BROWN having left the Oerlikon Works, has become a member of the new electrical engineering firm of Brown, Boveri & Co., of Baden, Switzerland.

A PRACTICAL WIRE TEST.

WITH the varied uses to which electricity is now being put, the tests given to the insulation used are often quite severe, and the way in which some wires stand these tests speaks well for the state of the art. George Cutter recently sent a large batch of Simplex braided rubber wire out to Utah, where it was apparently to be used for indoor wiring. But as it happened to be close at hand when some blasting was to be done at the Anchor Mine, at Park City, Mr. Ewing, of the United Electric Co., calmly used some of it for this purpose.

The object of the blast was to break through the bottom of a 900-foot shaft into the Anchor drain tunnel, whereby the mine could be drained. The water in this shaft was up to the 300-foot level, or 600 feet deep—260 pounds pressure. The dynamite was encased in a sheet-iron tube together with the electric exploders and lowered by means of a No. 14 Simplex braided rubber wire through the 600 feet of water to the bottom of the shaft. The first trial was not successful and the torpedo was pulled up, and it was found the water had got into the torpedo through a poorly soldered joint in the sheet-iron and wet the exploder wires. To test the leading wires 2,000 feet of wire was placed in a barrel of water and allowed to remain over night. The next morning six caps were successfully exploded through the 2,000 feet of wire in the barrel of water. The repaired torpedo was then lowered to the bottom of the shaft and exploded, using Simplex braided rubber wire that had been under water from 20 to 24 hours continuously. While the work was a complete success electrically, yet it failed to break the shaft through into the tunnel, as some error had been made in surveying the tunnel.

With an insulation that will stand such tests, it is not surprising that many of our leading architects feel as proud of the electrical fittings in their buildings as of any of the details which they work out themselves.

CROCKER-WHEELER ELECTRIC MOTOR COMPANY.

THE Crocker-Wheeler Electric Motor Company, New York City, have just issued a revised and extended catalogue. It is an interesting pamphlet of over fifty pages. To those seeking information regarding the electric motor, and its numerous applications, the Crocker-Wheeler catalogue must prove of great value. The text, which is profusely illustrated, discusses at length the construction of the Crocker-Wheeler motors, and their special features, with convenient and valuable table of dimensions, etc. There are also directions for setting up, connecting and running. An interesting chapter on "Windings" engages the attention, also a table of sizes and types of motor manufactured for constant potential circuits. The fireproof starting, regulating and reversing boxes made by the Crocker-Wheeler Motor Company are described, and considerable space is given to their small motors, one-sixth, one-eighth and one-twelfth h. p., together with their application to electric fans, electric pumps, etc.

The "arc" circuit or constant current motors, Crocker-Wheeler type, are fully described and illustrated. The pamphlet further contains "A Visit to the Crocker-Wheeler Electric Motor Company's Factory," reprinted from THE ELECTRICAL ENGINEER, New York, and an interesting paper on "Cost of Electric Power—Comparative Efficiency of Large and Small Motors," by Dr. S. S. Wheeler.

THE PULLMAN PALACE CAR "VENICE."

AMONG the social features of the Street Railway Convention was the entertainment of a party of men interested in street railway matters and members of the scientific press on board the palace car "Venice," which by the courtesy of the Pullman Palace Car Company and the *Street Railway Gazette* was placed at their disposal. Mr. P. G. Monroe, president of the *Gazette*, and Mr. W. S. Louttit, of the Pullman Car Co., entertained the party royally, and a hearty vote of thanks was tendered them for their many courtesies.

The "Venice" went by way of the Erie road to and from Pittsburgh, at which point it was side-tracked and used as a hotel during the stay. The party of guests was composed of W. H. Patton, George Standart, C. K. Harding, F. H. Stanwood, W. H. Edgar, Jr., N. P. Senat, John Roberts, E. L. Powers, G. G. McDuff, H. L. Webb, L. W. Collins and W. F. Collins.

THE CENTURY POTTERY, which has recently been established at 514 Liberty street, Camden, N. J., is turning out some very creditable work in the way of vitrified porcelain for electrical purposes. The general manager, Mr. H. Wareham, is a thoroughly practical man, having had many years' experience in the porcelain business both in Europe and the United States, and possesses some receipts known only to himself for mixing the ingredients which produce the best results.

BAIN'S COMPENSATING VOLTMETER AND AMMETER.

THE desirability or, rather, the necessity, of accurate instruments to measure the strength and voltage of currents is now so well recognized as scarcely to require further comment. Nevertheless, it cannot be urged too strongly that to obtain economy of operation in incandescent lighting, for instance, requires the maintenance of the proper potential, and that a slight increase above the normal entails a very much decreased life of the lamps. On power circuits, also, voltmeter and ammeter records continuously maintained will afford much valuable information.

To meet the demands for such instruments Mr. Forée Bain, of Chicago, has recently designed a set of voltmeters and ammeters, the manufacture of which has been undertaken by the Knapp Electrical Works, of 54 and 56 Franklin street, Chicago, and the general design of which is illustrated in the accompanying engraving.

The action of the instrument is based on the dynamic effect of moving electric currents and that due to electromagnetism, both affecting in a varying but compensating manner the movable armature, which is made of a small bit of chemically prepared sheet-iron, one-fortieth of an inch in thickness. The moving portion weighs only one-sixtieth of an ounce complete, the whole being mounted on very delicate trunnions. There is no appre-

BAIN'S COMPENSATING VOLTMETER AND AMMETER.

ciable friction, so that the pointer comes to rest every time at the same position, when not in use. The controlling force is gravity, with the parts balanced in such manner that its value is unchangeable during the entire range of the pointer. The two forces, electro-dynamic and electromagnetic, act from opposite sides, so that the increment of one of the forces is coincident with the decrement of the other to a degree that is exactly compensating. These forces in the relation described neutralize any tendency to magnetic lag or retardation. The instrument has no permanent magnets which are subject to change of strength and to tempered strain fracture. The instrument is absolutely dead-beat and yet extremely sensitive, having practically no inertia. The indicating pointer quickly and positively moves to new positions with slight variations of current.

The voltmeters are wound with a resistance wire which changes in resistance, but very slightly with increased temperature, so that it may remain in circuit indefinitely. The proportion of current necessary to operate these instruments is extremely small. They have a scale from 0 to 150 volts, and are wound for 15,000 ohms resistance, therefore requiring only one-hundredth of an ampere to deflect the needle the whole length of the scale.

The appearance is neat and substantial without being clumsy. The brass case is circular in form and is firmly mounted on a highly polished hardwood base. The relation between the scale and the movable indicator is firmly maintained by a metallic structure; the moving portions are light, weighing about one-sixtieth of an ounce, and are of such shape that they may be readily duplicated. The aluminum pointer extends over a mirror to an engraved metallic scale, so that an error by displacement, due to parallax, may not be made when taking readings. When used as a portable instrument, it may be hung on the wall or held in an upright position in the hand. Each instrument is enclosed in a neat mahogany case, with leather handle for use as a portable instrument.

WESTERN NOTES.

MR. GEO. H. MEEKER, manager of the New York Insulated Wire Co., No. 78, 80 and 82 Franklin street, Chicago, has received the first of the shipment of the three carloads of Grimshaw white core wires and B. D. wires from their factory at Wallingford, Conn. In this shipment there is one million feet of their celebrated trade Nos. 228 and 237 No. 14 B. & S. wire, or more than enough to reach in a straight line from Chicago to Davenport, Ia., and the total shipment if strung on poles would nearly reach across the United States. The flattering and satisfactory success that this company have made with the sale of their goods since opening the Chicago store has warranted such shipments. Their Vulca electrical wire ducts are about to be installed in the new Masonic Hall at Utica, N. Y., and are being extensively used throughout the West.

THE ILLINOIS ELECTRIC MATERIAL CO., 158 Fifth avenue, who recently secured the general Western agency for the Fibrous dry battery, manufactured by Thompson & Robertson, New York, report having already secured a number of large orders for these batteries, which are specially made for bell and open circuit work. This company have also placed upon the market a new form of "Canvas Jacket" insulated with a special waterproof tape and a single weave above it, making a very high grade line wire, and are already overrun with orders. They are also doing a large business in Bishop wires and cables. The sale of cedar poles, of which they have quite a large share, shows actively in construction work. Electrix socket-switch and other specialties are in good demand.

THE CHICAGO ELECTRIC MANUFACTURING CO., 73–75 W. Jackson street, recently equipped a testing department, and are already handling a large amount of work. This department pays special attention to calibration of testing instruments, has all necessary standards and apparatus for delicate and accurate work, and is in charge of an experienced electrician. Voltmeters or ammeters of doubtful accuracy, bridge sets, coils of which need adjusting or galvanometers of which are not sensitive, magneto bells that refuse to ring, galvanometers in which the needles require remagnetizing or the coils are burned out, can be tested, rewound, calibrated and adjusted on short notice and their accuracy guaranteed.

THE GRAY ELECTRIC CO., recently organized to manufacture the Telautograph, have purchased a 50 acre tract about a mile south of Highland Park, Ill., and have let their contracts for the erection of the factory building, which will be 60 feet wide and 140 feet deep, three stories, and will be pushed to completion with the greatest possible expedition. It is expected that the structure will be finished by March 1, and actual business of the manufacture will commence immediately thereafter. Prof. Gray is president; F.W. Cushing vice-president; Thomas G. Wheelwright, secretary and treasurer.

"THE ELECTRICAL NORTHWEST," published in St. Paul, Minn., has been purchased by W. L. Klein, publisher of the *Northwest Builder and Decorator*, and the name of the paper has been changed to that of the *Street Railway and Electrical News*, of St. Paul and Chicago. Mr. Gilbert G. McDuff, well known among the electrical fraternity in the West, has associated himself with the paper, with headquarters in Chicago.

MR. GEORGE CUTTER, the widely known dealer in electrical specialties at 332 "The Rookery," reports an astonishingly large demand for his "Lamp Supporting Pulley." This is conclusive evidence in Mr. Cutter's judgment that electrical construction work is active. In other lines of specialties he is also doing a good business and his devices, which are both highly practical and also ornamental, are becoming more largely used every day.

THE SUNBEAM INCANDESCENT LAMP CO. are now prepared to ship at short notice 10, 24, 25 and 32 candle-power lamps. They have been so rushed in their standard 10 c. p. lamps that they have been unable earlier to complete facilities for manufacturing promptly other sizes, but now have the new machinery and apparatus all installed, enabling them to open with a large business.

THE BOILER DEPARTMENT of the Pond Engineering Company reports increased activity, particularly in electric light and power work. Recent orders for steel boilers come from Kansas City, two; Jefferson City, two; Valparaiso, Ind., two; Waco, Texas, two; Laredo, Texas, second order; East St. Louis, Ill.; Waterloo, Ill.; Paducah, Ky.; Lawrence, Kan., and Arkadelphia, Ark.

THE ELECTRIC MERCHANDISE COMPANY, 11 Adams street, Chicago, is still engaged with the same rush of business that has occupied its attention during the summer and begins to wonder if the customary cessation is really to be experieneed this winter. Present indications are against it. For its standard line material, station and car equipment an ever-increasing demand is reported, while repeated large orders for Pratt's portable conductor's register and the Burton electric heater are being filled.

THE GREAT WESTERN ELECTRIC SUPPLY Co have issued a very handsome catalogue of their electric lighting snpplies. It is bound in cloth, and the typographical work and illustrations which, are very numerous, are of the highest class of work. Everything pertainining to electric lighting is illustrated and described, and the book forms one of the handsomest and most comprehensive catalogues ever issued by them.

MR. CHARLES E. LEE, Western manager of the Electric Gas Lighting Co., Lakeside Building, Chicago, reports business as brisk in their various specialties and general electrical supplies. Mr. Lee carries a large assortment of this company's well-known goods and electrical apparatus, and makes a special point of filling orders with promptness and despatch.

MR. WM. HOOD, 239 La Salle street, is having a brisk run of business with "Jewel' incandescent lamps and receiving numerous orders all the time. The Jewel lamps are giving excellent satisfaction, and the small amount of current they use, together with long life and freedom from blackening, are calling forth many commendations.

THE GREAT WESTERN ELECTRIC SUPPLY Co. have recently made some very large sales of line wire for extensions and new plants. The Sun arc lamp which they manufacture for both arc and incandescent circuits, is becoming quite a general favorite and they are continually booking large orders.

GEORGE CUTTER is putting out another size of his lamp-supporting pulley under the name of "Cutter's Petite Pulley." It is not exactly a pocket edition, but is intended for use with incandescent lamps and will find a ready market wherever such lights are hung over the centre of streets.

MESSRS. MCKINLOCK and W. F. RICHARDSON, of the Southern Electrical Supply Co., of St. Louis, spent a few days in Chicago last week. They report business in St. Louis and throughout their country as excellent.

THE STANDARD LAMP AND MOTOR CO., manufacturers of incandescent lamps for all systems, have removed to Oconto, Wis., where they have put in a new plant and built a large factory for the manufacture of lamps.

MR. THOMAS M. BROOKS, who is one of the well known belting men and for a long time sold Hoyt's belting, and later with the Page Belting Co., of Concord, N. H., has now associated himself with Fairbanks, Morse & Co., Chicago.

MR A. E. CURRIER, of the Faraday Carbon Co., of Jeannette, Pa., was in Chicago last week, and reports trade as very flourishing. The Faraday Carbon Co. have just completed their new factory, giving a capacity of 12,000,000 carbons per year.

GLEASON & BAILEY MANUFACTURING CO. report business as good in their electrical supply department. They are selling large quantities of the Steuben incandescent lamps, for which they are general Western agents.

THE ELECTRIC MERCHANDISE CO. are receiving some flattering testimonials regarding the "Chicago" trolley hanger. One enthusiast after trying them says they are good, and encloses a large order.

THE BALL ENGINE CO., of Erie, Pa., have recently opened handsome offices at 506 "The Rookery," Chicago, in charge of Mr. Albert Fisher, who is one of the best known among engine salesmen.

MR. CARL YOUNG has severed his connection with the Thomson-Houston Co. and will now handle the Jenney Electric Motor Co.'s apparatus, assisting Mr. Fred'k L. Merrill, as Chicago city agent.

MR. P. C. BURNS, of the Peru Glass and Carbon Co., was a Chicago visitor last week and found trade very brisk in his many well-known carbon, porcelain and other specialties.

THE KNAPP ELECTRICAL WORKS report a flourishing business in "Safety" insulated wire and cables, and a good demand for general electrical construction supplies.

THE CENTRAL ELECTRIC CO. are pushing the sale of Paiste switches, of which they have a large stock, and can fill almost any kind of an order from their warerooms.

MR. C. E. OLDACRE, the popular general agent of the Jenney Electric Motor Co., of Indianapolis, was a Chicago visitor last week.

MR. JAMES MCBRIER, president of the Ball Engine Co., of Erie, Pa., was a welcome visitor to Chicago last week.

NEW YORK NOTES.

MR. FRANCKE L. WOODWARD, of Albany. N. Y., member of the American Institute of Electrical Engineers, is making some valuable researches in the electrical field. At present he is developing a battery, it is said, on a principle that has never been used before, which, if a success, may be of use in aërial navigation.

MR. JAMES B. OLSON, of the New York Insulated Wire Co., has recently been on a flying trip through nearby States, taking in the American Street Railway Convention, en route for points in Pennsylvania.

THE new boiler-house for the Oswego Pulp and Paper Co., at Fulton, N. Y., will be of iron designed and built by the Berlin Iron Bridge Co., of East Berlin, Conn.

MESSRS. THOMSON & ROBERTSON, manufacturers of the Fibrous battery, have removed from 258 to 261 Broadway.

PHILADELPHIA NOTES.

MR. CHARLES K. WESTBROOK, manager of the Isolated Light and Power Department of the Thomson-Houston Electric Light Co., announces the following recent sales and installations of isolated apparatus by his department, viz., A. B. Farquhar & Co., York, Pa., 250 incandescent; W. A. King & Co., Columbia, Pa., 100 incandescent; Wilson Female College, Chambersburg, Pa., 300 incandescent; J. K. Mosser, Allentown, Pa., 150 incandescent; Chambers Brothers & Co, Philadelphia, Pa., 250 incandescent; S. S. White Dental Manufacturing Company, Philadelphia, 300 incandescent; Shaw, Esrey & Co., Chester, Pa., 625 incandescent; G. W. Blabon & Co., Nicetown, Pa., 155 incandescent; C. H. Reiser, Philadelphia, 300 incandescent: Wanamaker & Brown, Philadelphia, 75 arc; Bethlehem Iron Company, Bethlehem, 50 arc; Baltimore and Ohio Railroad Company, Baltimore, Md., 50 arc; Pennsylvannia Railroad Company, Altoona, Pa., 50 arc; William Sellers & Co., Philadelphia, 35 arc; Tyrone Iron Co., Tyrone, Pa., 18 arc; Norristown Steel Company, Norristown, Pa., 9 arc; Pencoyd Iron Works, Pencoyd, Pa., D 80 generator; Girard Estate for Burk & McFetridge, Philadelphia, 7½ h. p. motor.

THE WEST END ELECTRIC CO., whose plant has recently been put in motion to give light through the 29th ward, the district covered by their franchise, sent out about 800 invitations to their patrons and the electrical fraternity to inspect their plant a few evenings since. It is located at Thirty-first street and Girard avenue. The main building was brilliantly illuminated and in the centre were long tables bountifully filled with everything conceivable in the way of cold lunch and the beverage for which that neighborhood is famous. Their superintendent, Mr. A. J. Martin, did all in his power to entertain the many visitors present and explained the workings of the machinery and the many conveniences this plant possesses. The dynamos and electrical appliances were installed by the Thomson-Houston Electric Co. The engines are from the Providence Engine Works, the boilers of the Coatsville make, and over 15 miles of rubber insulated cables have been laid by the Bishop Gutta-Percha Co., of New York, through the McDonald conduit. The company has spared no expense in making this a model plant in every particular.

THE enterprising manufacturer of electrical specialties, Mr. H. T. Paiste, owing to increased business, has been obliged to move his factory and Eastern office from 12th and Market streets, Philadelphia, to the new Fuller Building, 10 South Eighteenth street, of the same city. He has taken the entire third floor of this elegant building, thereby trebling his floor space. It is the intention of Mr. Paiste to largely increase his stock of specialties. The Western office and storeroom, 341 the Rookery, Chicago, remains unchanged.

THE LA ROCHE ELECTRIC WORKS are installing a 500 light plant complete for Messrs. Wm. P. Froth, Jr., & Co. gingham manufacturers at Frankfort, Pa.; also a 50 light plant for Mr. T. J. Oliver, 19th and Reed streets. The latter will displace another machine of well-known make. The La Roche company are adding more power to their works in the way of a large Racine automatic cut-off engine. This engine will soon be in operation, and is intended to drive their plant at night.

THE STAR ELECTRIX CO. have since their recent cut in prices increased their force from 60 to nearly 150 operatives, and are shipping their specialties in large quantities throughout the United States and parts of Europe.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE

Electrical Engineer.

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MR. EDISON'S LATEST STREET RAILWAY WORK.

THE interest manifested not only by electricians, but by the general public as well, in the inventions of Mr. Edison has naturally induced the daily press to seize every occasion to place before its readers any new work upon which Mr. Edison may be engaged, and generally to give wide publicity to everything with which Mr. Edison's name is connected. Unfortunately, however, those to whom the task of interviewing Mr. Edison on such occasions is delegated by the daily press are rarely, if ever, sufficiently equipped with a knowledge of electrical matters to comprehend thoroughly the plans and results which Mr. Edison communicates to them, and, as a result, we frequently find the most absurd stories set afloat in which "the Wizard of Menlo Park" is quoted as using language whose picturesqueness subsequently turns out to be largely due to the vivid imagination of the reporter. The most recent example of such a published interview is to be found in an article appearing in the New York *Herald* a few weeks since, followed up by others in other papers, in which the reporters put into the mouth of Mr. Edison a number of statements which, it cannot be denied, have had considerable influence in electric railway circles, and have called forth comments in various quarters similar to those which have appeared in the last two issues of this journal. Mr. Edison, according to the reports of the daily press, was credited with having invented a system which, operating at low potential and using the rails as conductors, would do away entirely with the necessity for the overhead trolley system. The effect of the publication of such a radical change in our methods of electric railway construction has been, in some instances, to lead intending investors in electric railway enterprises to defer proposed action until this new system should be thoroughly worked out or explained, and, on the other hand, is said to have afforded the authorities of cities in which railroad franchises were asked for, plausible ground for taking the stand that, since such a system as that credited to Mr. Edison was available, no franchise for overhead wires should be granted.

In order, therefore, that the feeling of uncertainty which seems to exist in electric railway circles at the present time may be removed and the ideas of, and actual work accomplished by, Mr. Edison on his new system should be comprehensively and accurately stated, we give below the results of a thoroughly exhaustive discussion of this subject had with Mr. Edison by a member of THE ELECTRICAL ENGINEER staff, and which we are certain will lead to the conviction that the work Mr. Edison has referred to is not merely the outcome of speculation, but is the result of an actual experiment on a commercial scale.

In order that our readers may be brought to a thorough understanding of Mr. Edison's recent work, it may be well to give a little of its early history. As far back as 1880, Mr. Henry Villard, at that time president of the Northern Pacific Railway, applied to Mr. Edison to devise for him a system of electric railways which should be comparatively cheap of operation and act as branch roads, and particularly as wheat feeders, to the Northern Pacific Railroad. Acting under this stimulus, Mr. Edison designed, and actually built, models of a system resembling in all essential details that which has been the subject of recent comment. Although not carried out in practice, the system devised for that particular purpose was kept constantly in mind by Mr. Edison, awaiting only the proper moment and a suitable time for its practical demonstration. About two years ago, Mr. Villard, having become president of the Edison General Electric Company, requested Mr. Edison, as electrician of the company, to devise a street railway system which should be applicable to the largest cities where the use of the trolley would not be permitted, where, if possible, the conduit should not be used, and where in general all the details of construction should be reduced to the simplest possible form. The limits within which Mr. Villard confined Mr. Edison were, simply, that the system so devised should not cost more than a cable road to install.

With these conditions placed before him, Mr. Edison reverted to his idea of nearly ten years before, and had thus settled upon a system in which current should be conveyed from the central station at high potential to motor generators placed below the ground in close proximity to the rails, and which should convert the current transmitted at the pressure of, say, 1,000 volts to one of 20 volts between rail and rail, with a corresponding increase in the volume of the current. This arrangement, of course, does not embody any striking novelty, and, as Mr. Edison puts it, might have been devised by any one of fifty electricians in this country. The working out of the details of this system, however, was by no means a small matter. With the utilization of heavy currents at low voltage it became, of course, necessary to devise apparatus which should be able to pick up with absolute certainty 1,000 amperes of current through two inches of mud, if necessary. Mr. Edison at once set about to devise such a contact. For this purpose he experimented with a metal wheel, imitating, as nearly as possible, all the conditions of electric railway street traffic as regards speed of wheel and condition of track. It was several months before he succeeded in getting even 100 amperes by means of the contacts which had up to that time been employed; but after persevering trials a device has finally been evolved which can readily pick up a thousand amperes through two inches of mud.

Having provided for this difficulty, it was next necessary to obtain a joint between contiguous rails such as would permit of the passage of several thousand amperes without introducing undue resistance. This has also been accomplished with the result that an experimental track of about a quarter mile in length has been in actual operation near Mr. Edison's laboratory for some time past, and working to his complete satisfaction.

The objections to which rails charged at a potential of 20 volts and carrying enormous currents would be open were early foreseen by Mr. Edison, and, as a consequence, provided for. Thus it has been said that carriages with iron wheels passing over the tracks would short-circuit the current and cause the destruction of the dynamo machines as well as "chew up" the short-circuiting vehicle. To test this, Mr. Edison actually short-circuited his experimental track with a carriage having iron wheels, and succeeded in getting only 200 amperes through the wheels, the low voltage used, as well as the insulating properties of the axle grease, being sufficient to account for the small quantity of current which actually passed through. Again, the experiment was made of short-circuiting the track with an iron bar. As a result it was found that with the iron bar polished, and contact effected by a man standing upon the bar, only 1,000 amperes passed through it, that is, the amount which would be taken by a single car, and hence far below the capacity of the generators.

Probably the first difficulty which would seem to stand in the way of the successful solution of the problem in the manner undertaken by Mr. Edison would be looked for in the apparently large leakage of current between the rails in damp and wet weather. On this point the experiments of Mr. Edison are decidedly interesting. They have proved to him conclusively that at a potential difference of 20 volts the loss of current due to leakage between the rails under the worst conditions, with a wet and salted track, is only five h. p. per mile, while very wet weather would involve a loss of only two and a half h. p. It is interesting to note that in this respect the leakage observed between the car tracks follows identically the phenomenon observed on telegraph lines. With the latter it is a matter of common knowledge that in damp, murky weather, with the insulators covered with wet dust, the leakage is far greater than during rainy weather, when the insulators are cleaned by the action of the water. In the same way a heavy rain storm will reduce the leakage between the rails by washing away the accumulations between the tracks due to the droppings of horses, which serve largely to increase the conductivity. In dry weather the loss, evidently, is practically nothing, but even under the most disadvantageous conditions a loss of five h. p. per mile, as shown, may be neglected in practice.

What has just been said with reference to the track applies equally well to the motor. While not differing in principle from the ordinary type of street railway motor, the motor on this system would be practically waterproof without necessitating any special protective covering for that purpose, and in the experiments actually undertaken by Mr. Edison to determine this point the motor was left out in the rain unprotected, without giving rise to any subsequent troubles, showing that the matter of insulation may be practically ignored. As regards the question of safety to human beings and animals likely to come in contact with the rails, it is needless to say that the effect of 20 volts upon the human body is imperceptible, and actual experiment has also shown that horses are not affected by it in the slightest degree.

The cost of this system, Mr. Edison estimates, will vary between $30,000 and $100,000 per mile of double track, not including the cost of the stations, and depending, between these limits, upon the amount of traffic. The running expenses, he estimates, will be exactly the same as those on the overhead trolley wire systems. With this high initial cost, it is evident that the system cannot be, nor is it intended to be, applicable to any but the largest cities and the largest short roads, where the traffic is such as to warrant an expenditure of such magnitude; and the criticisms which have been made on the system are largely based on ignorance of this fact, which, it will be acknowleged, is one of pre-eminent importance. Although the cost, as above stated, may appear to be heavy, it can be very easily shown that, where the traffic permits of it, the system can be applied with far greater economy than a cable road. In the first place the latter would involve a greater expense, in proof of which we need only cite the fact that the Third Avenue cable railroad, now in course of construction in this city, was contracted for at the rate of $150,000 per mile without stations, while the Broadway cable road is estimated to cost not less than $300,000 per mile. But in addition to the item of first cost in favor of the electric railway must be considered the fact that the cost of operation of the electric road would be far below that of the cable. The traction efficiency of cable roads under the most favorable circumstances, it is well known, hardly exceeds 18 per cent. to 25 per cent., while 50 per cent. ought to be readily obtainable with the electric system. Another advantage, which, though of secondary consideration, should not be overlooked, lies in the fact that to install the system devised by Mr. Edison would require no extended tearing up of the streets and would offer practically no interruption to the traffic of existing roads, which could be converted in a very short time to the electric system.

In conclusion, we may add that estimates are now being prepared for the conversion of one of the largest street railways in New York city over to the electric system, after the plan of Mr. Edison, and it is to be hoped that arrangements will soon be effected by which the system may receive a practical trial on a large scale in the near future.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—XVIII.

BY

Chas. Steinmetz.

XI. Data of Some Commercial Transformers.

To see how the polar diagram looks in practical apparatus we produce as an instance two of the best types of commercial transformers, one of European make, a Ganz & Co. 10 h. p. transformer, tested by Prof. Kittler, and a small 1 h. p. Westinghouse transformer, tested at Cornell University by Prof. Ryan; both give fairly well the average shape of different types of transformer diagrams. One is a large "secondary generator," supplying a whole district, almost absolutely compounding and without magnetic leakage, a ring transformer with inside iron core and primary and secondary conductors wound on the ring over each other. The other is the smallest size of a high-frequency transformer, supplying only a few lights, with outside iron, and considerable magnetic leakage.

Of a commercial constant current transformer I am sorry that I could not gather any data. It would be of great interest, because just in these transformers many phenomena are more marked, which are of less importance in constant-potential transformers, as explained before.

A.—Ganz & Co. Low-Frequency 10 *H. P. Transformer.*

Tested or given data:

Cross-section of iron: 130 square centimetres.
Weight of iron: 95 kg.
" " copper: 40 kg.
Total weight: 175 kg.
Internal resistance of secondary: $r_1 = .0135$ ohm.
" " " primary: $r = 4.2$ ohm.
Number of secondary turns: $n_1 = 60$.
" " primary " : $n = 1080$.
Frequency: $N = 42.5$ complete periods per second.
Maximum output: 7500 watts = 10 h. p.

When running with full load:

Primary impressed E. M. F.: $E_0{}^1 = 1926$ volts effective.
" current: $C^1 = 4.28$ amperes effective.
Pressure at secondary terminals: $E_1{}^1 = 105$ volts effective.
Secondary current: $C_1{}^1 = 75$ amperes effective.

When running with open secondary circuit:

Primary current: $C^{\infty} = .17$ ampere effective.
Energy consumed by the transformer: 200 watts.

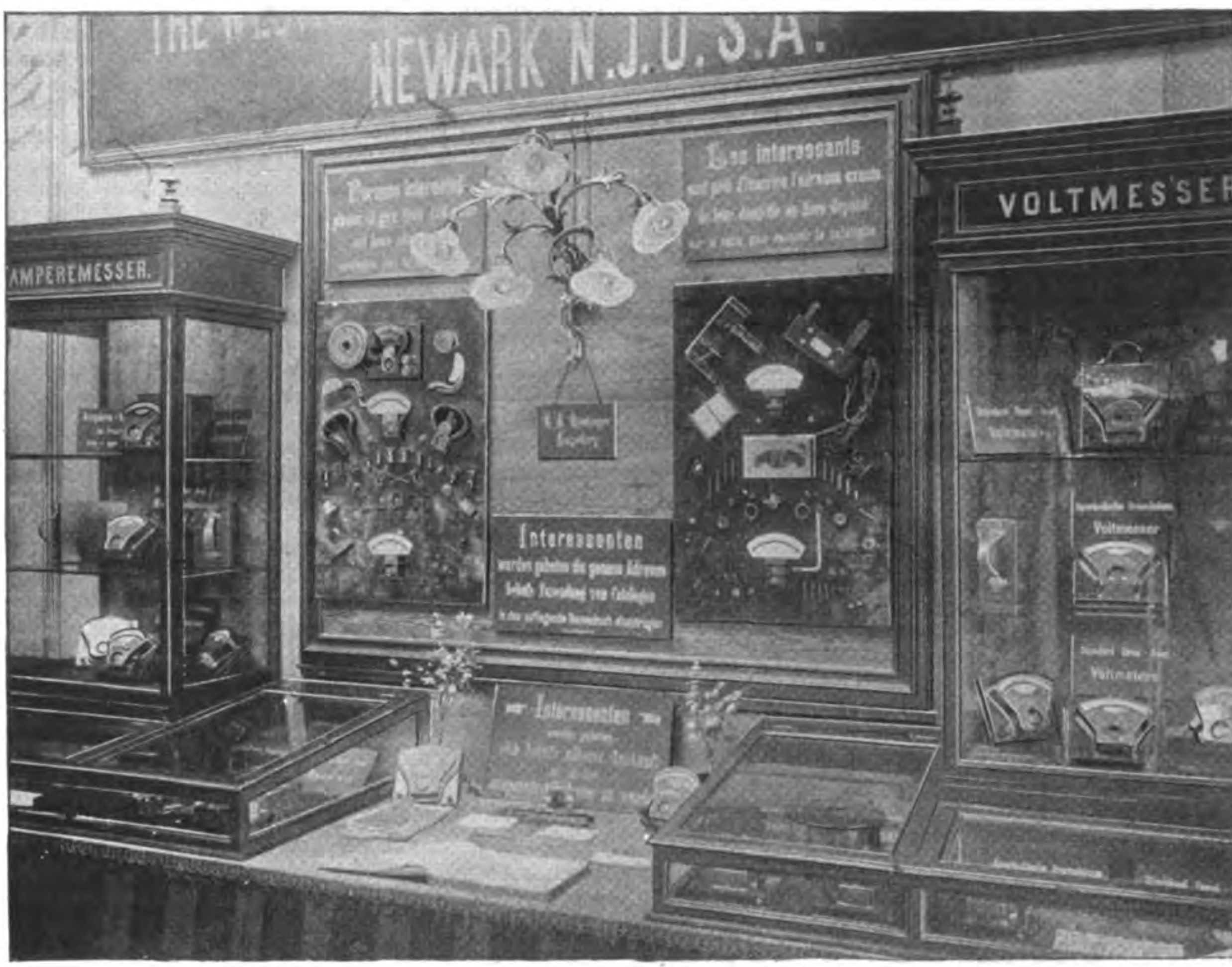
From this we derive, for the construction of the polar diagram, the results:

Magnetic resistance: $P = .00025$.
Magnetism: $M = 937000$ lines of magnetic force.
Magnetization, or induction: $H = 7200$ lines of magnetic force per square centimetre, maximum value.
Impressed M. M. F.: $K = 259$.
Ideal M. M. F. of hysteresis: $A = 114$.
Hence: resulting M. M. F.: $F = \sqrt{K^2 - A^2} = 233$.
Angle of magnetic lag: $\tan \alpha = \frac{A}{F} = .489$,
Angle $\alpha = 26°$.

speed at which the dynamo and engine run is 150 revolutions per minute, and the capacity of the dynamo is 19,250 watts running at 110 volts potential. There are three other dynamos shown, one driven by a steam engine of Swiderski, with a capacity the same as mentioned above; a second driven by a 12 h. p. gas motor at a speed of 375 revolutions per minute, and a third directly connected to an engine built by F. Voss, of Ehrenfeld; it has a capacity of 8,250 watts and runs at 280 revolutions per minute. Several motors of various sizes are also shown by this company in other buildings of the Exposition.

One of the most striking exhibits of its class is that of the Weston Electrical Instrument Co., of Newark, N. J. It might at first sight appear as a piece of hardihood for an American concern to attempt to compete with European manufacturers in the line of electrical measuring instruments, but it required just such an occasion as was presented by the Frankfort Exhibition to bring their merits before the European public. Perhaps no greater compliment could have been paid to Mr. Weston than the employment of his instruments by the official Testing Committee in their work.

The exhibit, which is illustrated in the accompanying engraving, was very tastefully arranged, and was in charge of Prof. R. O. Heinrich. It included a complete set of the various types of Weston voltmeters and ammeters. To those interested in fine electrical work the exhibit of the various parts which go to make up these instruments was somewhat of a revelation and demonstrated thoroughly the great care taken in their manufacture.



THE WESTON EXHIBIT AT THE FRANKFORT EXHIBITION.

THE FRANKFORT INTERNATIONAL ELECTRICAL EXPOSITION—X.

THE steam dynamo exhibited by the Electrotechnische Fabrik, J. Einstein & Co., Munich, in the "Haupt Maschinen Halle," consists of a dynamo directly coupled to a 125 h. p. engine built by Ph. Swiderski, in Leipsic; the dynamo has a capacity of 75,000 watts and works at a pressure of 125 volts. The speed is 200 revolutions per minute and the current is used for lighting the "Pfungstädter Bier Halle," the Cafés, the Labyrinth and Shooting galleries.

The exhibit of the Electrotechnische Fabrik, Carl Ilgner & Co., Minden i. W., consists of a dynamo directly coupled to a gas motor having a capacity of 30 h. p. The

THE ACCUMULATORS AT THE FRANKFORT ELECTRICAL EXHIBITION.—IV.

BY

D. Paul Schoop

It is easy to understand that the gelatinized cells are especially serviceable in all cases where batteries are moved or transported; for instance, in electric launches, street cars and velocipedes, and the lighting of ships, railway coaches, etc. There is a splendid electric launch on the River Main run by stored electricity. A battery of 34 cells, if the writer remembers aright, is placed at the bottom of the launch and connected with an electric motor of about 25 h. p. This launch, built to carry about 100 persons, was said to have been tried before on the Lake of Zurich, in quiet water, and absorbed between 10 and 15 h. p. at a speed of 10 to 14 kilometres per hour. The battery furnished the necessary current for 8 hours before becoming exhausted, and weighed about 3½ tons. All cells are filled with this stiff electrolyte, and the tops of the glass jars are covered by a layer of paraffine. The little ship may roll or pitch without causing any trouble in the battery, and is an object of interest to all visitors at the exhibition.

There is also a street car put into service by Messrs. Hostmann & Co., Hanover, making its daily regular trips from the Main River to the Jägerhaus (Waldbahn), a distance of some miles, which is said to give entire satisfaction. Of course, this does not mean very much, as this question depends entirely upon how much work an accumulator cell is likely to perform before its positive section has to be renewed, and what the cost of such accumulator work is per unit of cost of the accumulator plant. It seems worth trying, however, to get this experience with these cells containing gelatinized acid, as there is not the least doubt that these are superior to cells provided only with dilute fluid acid.

I may state right here, that at the time I was visiting the exhibition, not everything was finished, though it was at the beginning of August, and that the "Deutsche Accumlator-Actien-Gesellschaft" intended to put into use a street car and a small electric boat, both provided with so-called Tudor cells. It was a principal, fundamental point at this exhibition that it has been decided to make thorough tests of all electrical apparatus exhibited there by competent physicists and technical men, and to publish the results. Although it is hard to see how an opinion about a secondary battery cell could be given within so short a time, it will be, nevertheless, most interesting to know what has been found out. It is to be regretted that this exhibition is, in fact, *not* an "international" one, as claimed by the promoters, at least in regard to the accumulator show, since there are no English, American or French products to be seen. Where are the celebrated, but much abused, accumulators of the old Electric Power Storage and Light Co., London and of Elwell-Parker, Wolverhampton? Or the batteries of the French "Société Anonyme pour le Travail Élèctrique des Métaux," using the patents of Laurant Cély in a quite different way from the "pasting" of the English secondary battery cell? Is it just and right that all other kinds of reversible galvanic cells are lost to sight at this exhibition? Have the other types of accumulators no chance whatever to compete with the pure lead cell? We mean by this principally the copper accumulator as a perfection of the Lalande battery, well known in this country by the Edison-Lalande element, as first used for storage purposes by Commelin-Bailhâche and Demazures. Was it not claimed for that battery that the same work could be performed by it with only one-third to one-half the weight necessary with lead batteries? Is the form of the French copper accummulator not open to further perfection from both a mechanical and a chemical view, and is its rivalry with the lead cell out of the question?

Then there is the zinc accumulator, first adopted and worked out by Emile Reynier, Paris, put into a more promising shape in regard to the electro-chemical part by Meserole and taken up of late years in this country by Main. As is known, the voltage of such zinc accumulator is about 150 per cent. of that of the leaden cell, to wit, about three volts, and the capacity even higher than with the lead cells. Who can safely say that this cell will not be superior to the lead cell after it has been thoroughly experimented with and perfected?

The manufacture of electrical accumulators, as is known now-a-days, forms a part of that branch of electrical industry best designated by the name electro-chemistry. It is not the most important performance in this direction, as the electrical extraction and refining of copper holds already a larger amount of both work and capital occupied. If we mention here, as an appendix to the accumulator systems, the exhibits of the "Aluminium-Gesellschaft, Neuhausen," Switzerland, and the model of a plant for the electrical extraction of copper direct from the ore, put up by Messrs. Siemens and Halske, Berlin, we shall have mentioned nearly the whole of electro-chemistry. But last, not least, there is a little exhibit arranged by Professor F. Goppelsroeder, Mülhausen, Germany, of a striking appearance. Aniline dyes, made electrically, cotton printing by electrical reactions, and some other perfectly astonishing features are shown there. It is principally the artificial aniline-black and its production on the fibre itself, cotton, wool, or silk, which has been worked out during the last ten years by the inventor, and which are likely to be of practical use in a most promising manner soon. There are indigo and purple pieces of cotton, partly bleached or changed into sharp designs by means of electrical treatment for five minutes.

I may perhaps have occasion to consider more closely these other parts of the "Electro-Chemistry at the Frankfort Exhibition" in another article.

THE VARIATION OF THE ELECTROMOTIVE FORCES OF BATTERIES UNDER PRESSURE.

In a note contributed to *Comptes Rendus*, M. Henri Gibault states that the variation in electromotive force of batteries under pressure in cases where no gas is disengaged, may be expressed by a formula of the form

$$E_0 - E = a\,p - b\,p^2,$$

b being a very small quantity in cases where the pressures are not very great, the variation in fact being linear, which is in accordance with theory. In cases where gas is given off, the equation is

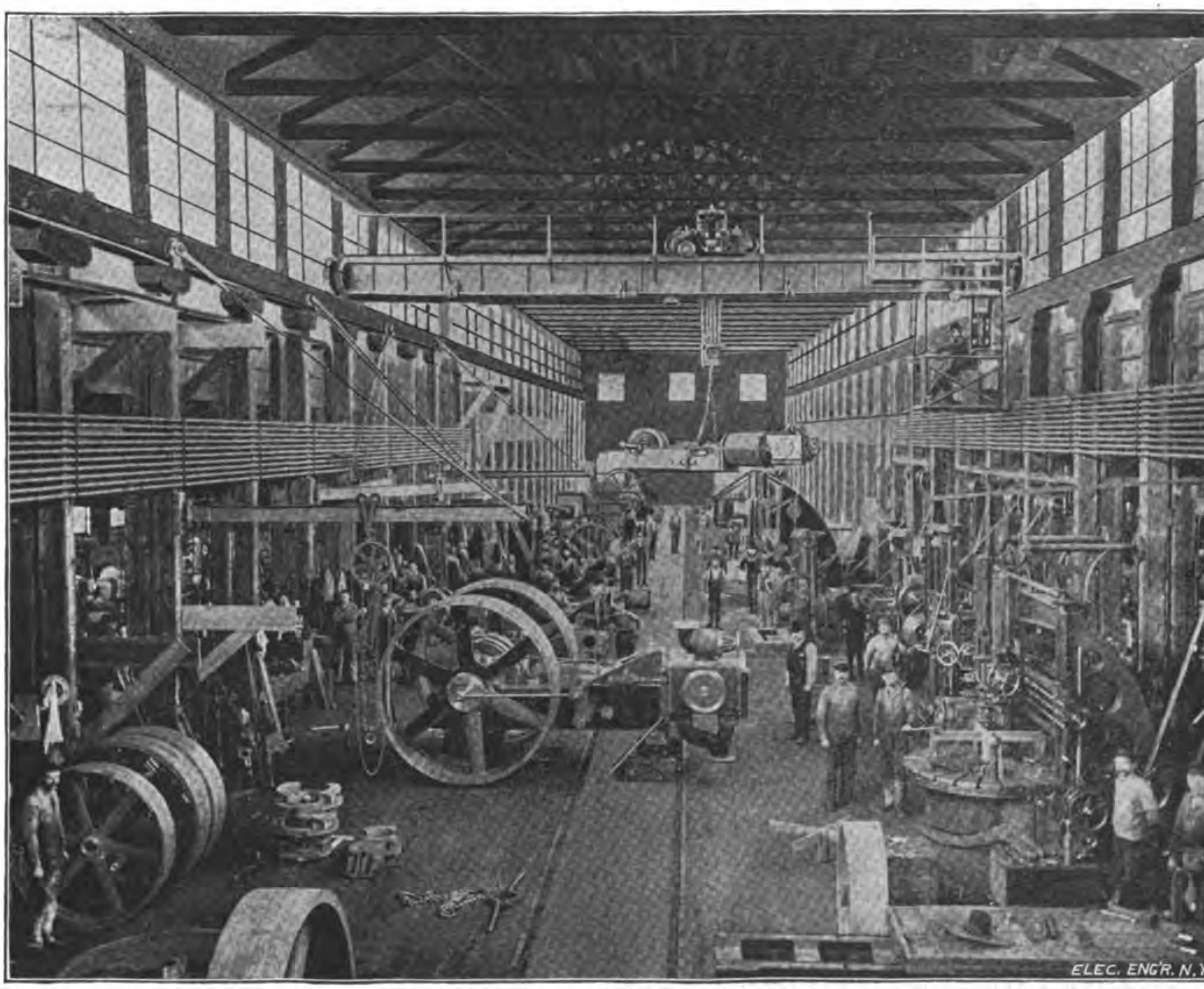
$$E_0 - E = A\,k\,p + c\,p,$$

c being very small; that is to say for moderate pressures the variation of force follows a natural logarithmic curve. The accord between theory and experiment is close, as may be seen by the following results:

Batteries.	Variations in $\frac{1}{1000}$ volt.	
	Calculated.	Observed.
Daniell (20 per cent. SO_4 *Zn*).........	+ 5.17	+ 5
" (27.56 per cent. SO_4 *Zn*)......	+ 2.2	+ 2
Warren de la Rue (1 per cent. *Zn Cl*)	+ 6.62	+ 7
" " (40 per cent. *Zn Cl*)	+ 5.04	— 5
Planté Accu. (8.8 per cent. SO_4 H)...	— 12.7	— 12
Volta..............................	— 586	— 600
Bunsen............................	— 388	— 405
Gas Battery........................	— 865	— 845

THE SHAW ELECTRIC CRANE AT THE McINTOSH, SEYMOUR & CO. WORKS.

THE use of traveling electric cranes in large shops has so greatly facilitated the handling of heavy parts of machinery that it may almost be said to have marked the beginning of a new era in machine-shop practice. One cannot but be impressed with the truth of this statement by a glance at the accompanying illustration, which shows a crane built by the Shaw Electric Crane Works, of Muskegon, Mich., at the works of McIntosh, Seymour, & Co., Auburn, N. Y., who have built so many large engines for electric light and power work, in the act of lifting a 150 h. p. compound engine.



HANDLING McINTOSH & SEYMOUR ENGINES WITH THE SHAW ELECTRIC CRANE.

This crane traverses the shop at the rate of 325 feet per minute and the carriage moves across at 120 feet, yet so delicate is the regulation that any weight, up to its full capacity can be moved $\frac{1}{16}$ inch in any direction. U. S. double reduction motors are used, two on the trolley carriage and one on the bridge, each one of which is entirely independent of the others, and an automatic brake controls the hoisting apparatus.

Messrs. McIntosh, Seymour & Co. say that this crane enables them to move heavy machinery twice as easily and five times as rapidly as the mechanical cranes previously used by them, and saves an enormous amount of labor. As an instance of this we may refer to the crane, recently shown in our columns, in the Baldwin Locomotive Works, which lifts a complete locomotive weighing 65 tons from one end of the shop and deposits it on the shipping track at the other end in about five minutes, an operation which used to take a large gang of men an entire night.

A NEW TELEGRAPH MACHINE.

A TELEGRAM from Berlin states that a new telegraphic transmitting machine has been invented by Herr Jaite, director of telegraphs. In the apparatus there are two electro-magnets, the one worked by a pocitive and the other by a negative current. These set in motion a perforator, whereby holes are punched in a tape. The holes, instead of consisting of mere dots and dashes, as in the Morse system, are so arranged that, on joining them with lines, the letters of the Roman alphabet are formed. The chief merit of the machine, says the report, is the extraordinary ease with which it can be worked. At a recent trial between the Berlin and Hamburg Stock Exchanges, a distance of nearly 200 miles, it was found possible to send from 65 to 85 messages per hour, or from 25 to 35 words per minute.

STANDARD FOR THE RESISTANCE OF COPPER.

BY

Silas W. Holman.

That the general adoption of a standard for the specific resistance of copper is much needed for technical purposes hardly admits of question. What that standard shall be is of far less consequence than that it shall be universally accepted. Now, it may safely be assumed that it is impossible to bring about the adoption of either a purely arbitrary standard (*e. g.*, soft copper, metre-gramme at 0° C., $=0.1400$ legal ohm), which would serve the purpose excellently, or a standard based on new investigations conducted, however thoroughly, by any local institution or society. It is therefore undoubtedly politic to turn to Matthiessen's classical work; and the American Institute of Electrical Engineers has acted wisely in following the current practice in that respect. To that extent therefore, I find myself in accord with the reports of its committee (on the Standard Wiring Table) which appear in the *Transactions* for November and December, 1890.

The object of the present note is, therefore, not to antagonize the efforts of the Institute in this matter, but rather to do what I may toward promoting the object in view. To this end I shall first point out a serious error in the temperature formula given by the committee, and, second, express my dissent from their main recommendation. In doing the latter I hope to show that a different recommendation might be more likely to meet with general acceptance, as well as prove otherwise more advantageous; and I trust that the opinions and reasons given may be those of many persons interested in the subject. I may also be permitted to express the hope that, as the matter is still far from a definite settlement, the attitude of the American Institute may yet be altered before the time comes for further action in reference to a universal convention on the subject.

The error referred to is as follows: One of the recommendations of the committee (*Trans.* p. 411) reads thus: "To find the conductivity of copper at temperatures other than 0° Cent., Matthiessen's formula may be used, viz:

$$C_t = C_0\,(1 - .00387t + .000009009\,t^2)\,; \qquad (1)$$

$$\text{or } R_t = R_0\,(1 + .00387t + .00000597t^2). \qquad (2)$$

The first of these, (1), is Matthiessen's formula for conductivity, and is correctly quoted, with a necessary change in the decimal point. The second, (2), purports to represent the same temperature variation expressed in terms of resistance. As (2) is identical in form with the formula given for the same purpose by G. B. Prescott, Jr., in an article in The Electrical Engineer (Vol. vii, p. 242, 1888), it is presumable that the committee adopted that formula. Unfortunately the Prescott formula, (2), is incorrectly deduced from the Matthiessen formula, (1), and its error is about 1.7 per cent. at 100° C. Before going into the cause of the discrepancy, however, I will give here, for convenience of comparison with (1) and (2), two correct formulæ deduced from (1) at my request by Mr. H. M. Goodwin, Assistant in Physics at the Massachusetts Institute of Technology. They are

$$R_t = R_0\,(1 + 0.004019t + 0.00000214t^2),$$
$$\text{Range } 0° \text{ to } 100° \text{ C.} \qquad (3)$$

$$R_t = R_0\,(1 + 0.003879t + 0.00000526t^2),$$
$$\text{Range } 0° \text{ to } 30° \text{ C.} \qquad (4)$$

They represent as nearly as such expressions with but two powers of t can do, the resistance-temperature function corresponding to the Matthiessen conductivity temperature formula (1). The reason for giving (4) in addition to (3) will appear latter.

The error in the Prescott formula, (2), arises from his use of the expression (*loc. cit.*)

$$r_t = r_0\,[1 + a\,t + (a^2 - b)\,t^2], \qquad (5)$$

by which to deduce the constants for (2) from those of (1). It is, of course, true that

$$\frac{r_t}{r_0} \times \frac{C_0}{C_t} = \frac{1}{1 - a\,t + b\,t^2}, \qquad (6)$$

where a and b are Matthiessen's conductivity constants. It is also true that

$$1 + a\,t + (a^2 - b)\,t^2 \qquad (7)$$

represents the first four terms in the quotient obtained by performing the division indicated in the last member of (6). The remaining terms, however, of the quotient which have been rejected by Mr. Prescott are not negligible except at low temperatures, but amount to 1.7 per cent. at 100° C. May it not be taken as certain that a formula so much at fault as this at high temperatures will never be generally accepted, although much less in error at the ordinary temperatures of practice?

The only available method of calculating the constants a' and b' for the desired expression

$$R_t = R_0\,(1 + a'\,t + b'\,t^2)$$

is to deduce values of $\frac{R_t}{R_0}$ for various temperatures, such as 20°, 40°, 60°, 80°, 100°, from values of $\frac{C_t}{C_0}$ computed from (1), and then to compute by the method of least squares the corresponding values of a' and b'. This is what Mr. Goodwin has done, arriving thus at formula (3). Matthiessen has given (*Phil. Trans.*, 1862, ciii, 25), values of $\frac{R_t}{R_0}$ deduced from (1), so that we may check our work at that point. These are quoted in the following table, which also shows the values computed from the Prescott formula (2), and from (3), and gives their percentage errors:

Temperature, Centigrade.	Matthiessen.	From (2) Prescott.	Percentage difference.	From (3).	Percentage difference.
20°	1.0797	1.0798	+ 0.01	1.0812	+ 0.14
40°	1.1633	1.1644	+ 0.1	1.1642	+ 0.08
60°	1.2497	1.2573	+ 0.33	1.2488	− 0.07
80°	1.3368	1.3478	+ 0.8	1.3352	− 0.12
100°	1.4222	1.4467	+ 1.7	1.4233	+ 0 08
			+ 0.6 Av.		0.1 Av.

It will be seen that both the extreme and the average error of the Prescott formula are from 6 to 12 times as great as those of (3), and that they are all of one sign. Nevertheless, (3) does not represent (1) as well as might, perhaps, be desired. This arises solely from the mathematical fact that using terms only up to t^2 in the series, it is impossible to have conductivity constants a and b and resistance constants a' and b', which will give results exactly coinciding.

Now, what we seek in connection with this matter of a standard is to obtain an expression reproducing Matthiessen's formula (1) as closely as possible, or rather closely enough to be generally accepted, regardless of how far his own various experimental data may have deviated from this. It has therefore seemed well to calculate constants for an expression whose range should be merely that of ordinary atmospheric and standard reference temperatures, as thereby an equation could be obtained which would, at the same time, cover all the conditions of technical practice, and exactly duplicate Matthiessen's values. This has been done by Mr.

Goodwin with the result given in equation (4). That this tallies with Matthiessen's figures with all desirable closeness appears from the fact that the values of $\frac{R_t}{R_0}$ computed from formula (4) exactly check those from (1) out to, and including, the fourth place of decimals (as far as Matthiessen carries his own computed values and further than they are reliable) at all temperatures up to the limit of 30°, and indeed somewhat above that limit. This is beyond the requirements of technical practice, as well as far beyond the concordance of Matthiessen's experimental data. Thus, formula (3) should be used for work above 30°, and (4) between 0° and 30° or 35°. Of course, if it were at all desirable, other formulæ could be computed to represent Matthiessen's values more closely at higher temperatures, *e. g.*, one serving between 30° and 60°, and another between 60° and 100° C. In recommending a formula for general adoption, it would doubtless be best to fix upon either (3) or (4) or some suitable expression, urging only a single formula.

It should be noted that Matthiessen's formula (1) is the mean of six (*Phil. Trans*, 1862.) obtained from three samples (the same which were used in the absolute specific resistance measurements) of copper, each sample being studied both before and after annealing. The material was electrotype copper in all three samples. Two of them were from the same piece, and all from the same source. Although the same sample gave a sensibly different temperature formula before and after annealing, yet the differences were less than the variations among the samples, so that Matthiessen preferred to use a mean of all. Thus (1) represents the change in hard drawn as well as annealed wire. It should also be remarked that, as these six formulæ differed among themselves at 100° C. by about 0.5 per cent., we cannot assume that (1) will apply with greater closeness than this to any sample which we may happen to have in hand. We adopt the Matthiessen formula, then, if at all, merely as represening the temperature variation of *his* copper, the same whose specific resistance we propose to adopt as a reference standard.

If we apply it to other copper, we must recognize that in so doing we presumably introduce an error of sensible, and perhaps of large, amount. For exact work the temperature correction of each sample must be tested, or the conditions of the test must be made such that the temperature correction is eliminated or the error introduced by the assumption that (1) applies to the sample is negligible.

Turning now to the question of a standard of specific resistance, it will be found that the committee, in the following words, quote, as a basis for further recommendations, Matthiessen's values for his pure copper: "A hard drawn copper wire, one metre long, weighing one gramme ('metre-gramme'), has a resistance of 0.1469 B. A. unit at a temperature of 0° Centigrade." From other data by Matthiessen (*Phil. Trans.*, 1864) they also deduce the value 1.0226 as the ratio of the resistance of his hard drawn to his annealed or soft copper.

These values check with those which I had deduced for my own work, and seem to be correct. But from the further recommendations of the committee I must dissent. The first of these is as follows, and it alone need be considered, as the others depend upon it: " . . . and the conclusion has been reached that the most correct and satisfactory 'Matthiessen Standard,' and the one which we recommend for general adoption, is as follows: A soft copper wire, one metre long and one millimetre in diameter ('metre-millimetre') has an electrical resistance of .02057 B. A. unit at 0° Centigrade."[1]

It must be perfectly obvious to any one who examines Matthiessen's work that the metre-gramme value, 0.1469 B. A. unit at 0° Centigrade, is the one which he held as best representing his own results on hard copper. From this and the ratio 1.0226 the metre-gramme of soft copper is 0.14365 B. A. unit at 0° Centigrade, or 0.14206 legal ohm at 0° Centigrade. Also, from the fact that for the specific resistance by length-section (metre-millimetre, cubic-centimetre, foot-mil,[2] etc.,) the computations were all based on diameter measurements of wires from 0.5 to 0.7 mm. in diameter, it is equally obvious that Matthiesen's metre-millimetre value is far less accurate than the 0.1469, and that he so regarded it. This fact is, of course, not a conclusive argument against its adoption, but why should we adopt it as the standard?

The primary reason appears to be that there is needed for engineers and dealers a table of pure, or at least of standard, copper wire, arranged according to size, rather than weight, of the wire. A length-section standard of resistance appears, at first sight, more directly in accordance with that desire. But on further consideration this reason loses its apparent weight, for *what we really need is two separate things, namely, first, a standard of conductivity or of specific resistance; second, a resistance table arranged according to size of wire.* The former will be used only in connection with accurate tests of the quality of copper, the latter never for that purpose, but only for wiring computations in engineering practice.

It is easy to see that such a wire table is not available as a criterion of the quality of a sample of wire, or at least only in a very rough way. Different wires of the same nominal size, in the market, are rarely of the same actual cross section. The differences are great enough to correspond to variations of several per cent. up to, say, No. 10 B. & S. Thus, of two wires of the same nominal size, the one of the poorer copper may have less resistance than the one of better copper, merely because actually of larger section, whether by design or accident. We cannot, therefore, except for rough work, depend on the measured resistance and *nominal* size, but must measure the section. And this can be done with sufficient accuracy to afford a test of the quality of the copper only by weighing in water. But this means that we must make a complete measurement of its length-section specific resistance, and if we have done that, then we have no use in that connection for the table, for we shall refer the resistance at once to the length-section standard which we may have adopted.

We come, therefore, directly back to a fundamental question, Is the length-section standard intrinsically better, or worse, than the length-weight standard? This is easily answered by showing that a length-section specific resistance measurement is more laborious and is subject to more sources of error than one in terms of length and weight. In both the electrical measurements are the same, and also the length measurement. For the length-section value we must weigh the wire in air and in water, with suitable precautions. For the length-weight value we have only to weigh in air. Thus the former determination involves the labor and sources of error incident to a specific gravity determination, which the latter does not. There seems to be no compensating advantage.

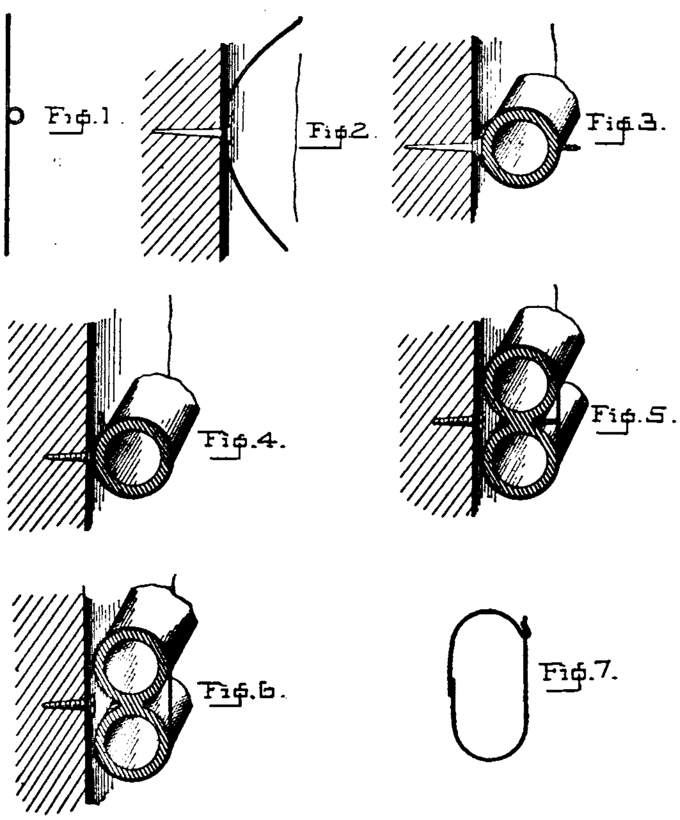
If a length-weight standard is adopted, then to compute the size-resistance table some value must be adopted for the specific gravity of copper. For this we may, if we choose, take a value deduced from Matthiessen's diameter measurements, as has virtually been done by the committee, or we may measure the specific gravity of a suitable variety of samples, and use the average value. The latter method would be by far the best, as it would give a value, and thus a table, not subject to sensible modification by later observers. For such a course there are three reasons. First, the Matthiessen value would almost surely be in error, and thus open to critical objection and to change. Second, the experimental value could be made so accurate

1. The fourth significant figure is in error in some of the values given by the committee, owing apparently to the retention of too few places in calculation.

2. This should be foot-mil, not mil-foot, both by analogy and because the prefix mil already carries another definite significance in scientific terminology.

that the residual error would be exceedingly small. Third, as the table is only useful for engineering purposes, a high degree of accuracy is not essential, so that the experimental value would be abundantly close, and there would be nothing to be gained by amending the table later, even if other investigations should lead to slightly different values for the specific gravity. Moreover, it is to be noted that, for similar reasons, it is of far less importance that there should be a universal adoption of a wiring table than of a standard of conductivity. Thus we can afford to throw over, altogether, the question of the adoption of a specific gravity, if by that simplification we can gain the main point, viz., a standard of conductivity.

The matter may then be summarized, as seen from the writer's point of view, as follows: Unless the whole subject is thoroughly reinvestigated by some such body as the International Bureau of Weights and Measures, or the German Standards Commission, the best and simplest value for the standard of specific resistance of copper, and the one most likely to receive general sanction, is;



Clamps for Interior Conduits.

Resistance of metre-gramme of Matthiessen soft copper at 0° Centigrade = 0.14365 B. A. unit = 0.14206 legal ohm. For this the Matthiessen conductivity-temperature formula (1) and a proper modification of it into a resistance-temperature formula should also be adopted.

A NEW DRY CELL.

A new dry cell, brought out by Herr Leo Graef, in Rotterdam, is said to possess a high electromotive force with extremely good recuperative properties. From tests made it appears that a cell on open circuit gives 1.55 volt. On being closed on a 50 ohm circuit for 13 minutes the volts fell to 1.50, but had again risen to 1.54 after four minutes' rest. On external resistances of 10 ω, 5 ω, and 10 ω respectively the volts after 15 minutes fell to 1.41, 1.31, and 0.95; but a four minutes' interval was sufficient in the last case to raise them again to 1.30.

CLAMPS FOR INTERIOR CONDUITS.

BY

Augustus Noll

The ordinary method of fastening interior conduits to sidewalls and ceilings is unduly expensive, both in point of time and the cost of a special band or buckle of brass. The use of staples makes it possible for the man driving them to miss his aim and strike the tube, cracking or breaking it. Being out among the users of tubing, and hearing the various complaints, I have given this matter a little attention and have struck what I think is the best way.

Instead of using the broad, thin strips of brass, bought by the hundred, I use a thinner piece of brass or galvanized iron, No. 12 or 14, B. and S. This piece is twisted once around the nail or screw, which is then driven into the wall. Fig. 1 shows the twisted wire. Fig. 2 shows the twisted wire with the nail, and Fig. 3 shows the nail driven home and the wire holding the tube in position. Fig. 4 shows the twist of the wire on top of conduit, where it will be out of sight. This can be done when the tube work is exposed.

Fig. 5 is the same as Fig. 3, except that a duplex instead of a single tube is used.

Fig. 6 represents a duplex tube held in place by a wire clamp or pin. Instead of twisting the ends, it is held in position like a safety pin. Fig. 7 shows the design. The twist is where the nail or screw is inserted, and when this is driven into the wall the pin is held in position. These can be put up first, and then the tubing can be laid in and locked. This is a handy and neat way of fastening the tubing where it is exposed, as the only thing that will show is the small line of wire across its face.

THE DETERMINATION OF THE AVAILABLE ENERGY OF WATER POWERS.[1]

BY

Francis R. Hart.

The total work which a given quantity of water, falling a given number of feet, is capable of doing is expressed by the following formula:

$$W = L \times h,$$

where W, is the total work in foot-pounds,
L, the weight of water in pounds,
and h, the height in feet through which it falls.

If we let Q be the quantity of water falling in cubic feet per minute, and call 62.34 pounds the weight of a cubic foot, we have the total energy in horse-power,

$$E_t = \frac{Q \times h \times 62.34}{33{,}000}.$$

Of the total energy of the falling water, a certain proportion, varying chiefly with the size and description of the water-wheel or turbine used, can be utilized. This proportion represents the efficiency of the system. Calling this efficiency, or percentage of total power which is available, k, we have for the available energy in horse-power,

$$E_a = \frac{Q \times h \times 62.34}{33{,}000} \times k.$$

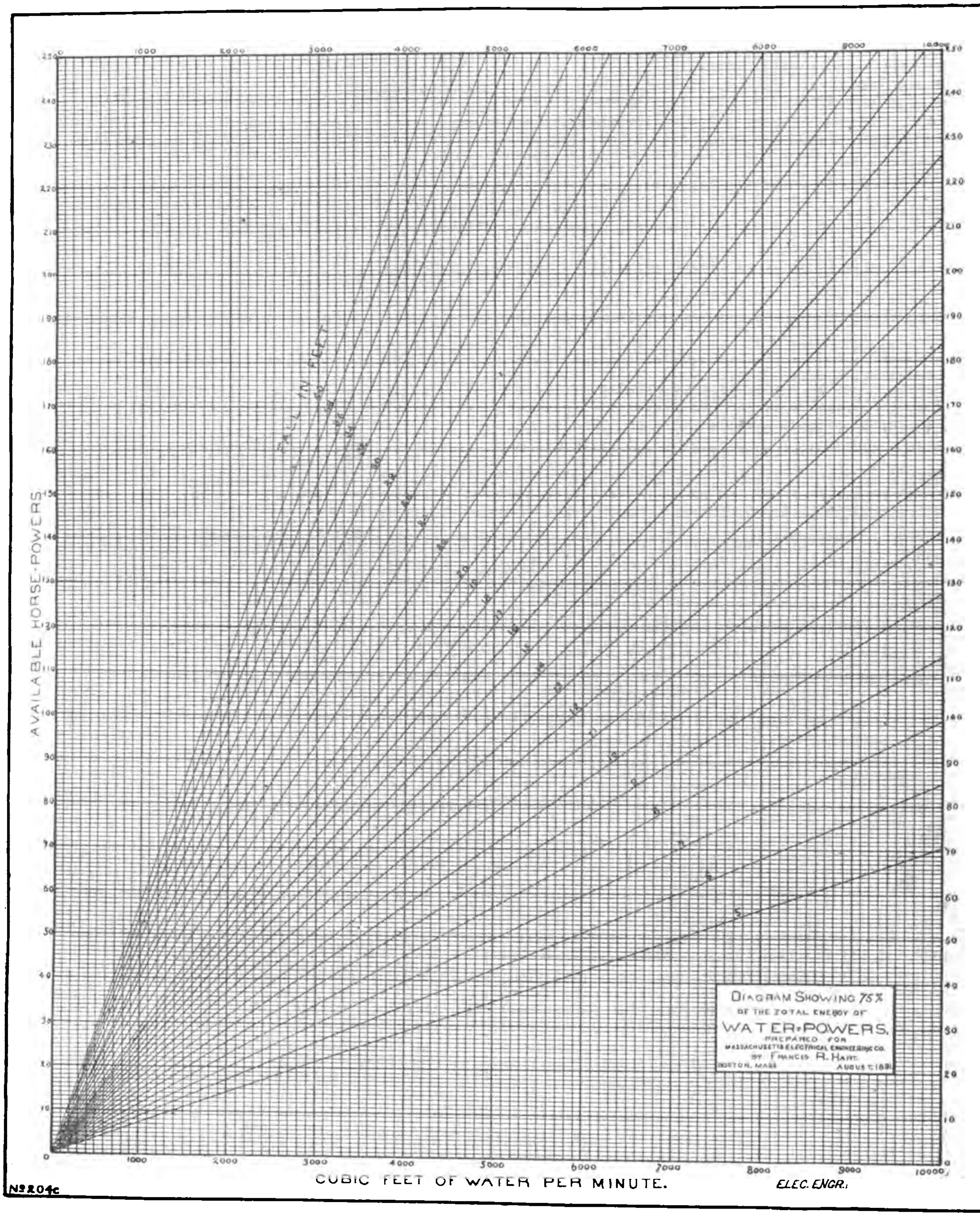
The accompanying diagram showing Available Horse-Power has been calculated with an assumed efficiency of 75 per cent.

To determine the available horse-power from the diagram, it is necessary to know the flow of water in cubic feet per minute and the fall in feet. The abscissæ repre-

1. Contribution from the Laboratory of the Massachusetts Electrical Engineering Company.

sent the cubic feet per minute, the ordinates the available horse-powers, and the diverging lines the fall in feet.

To illustrate the use of the diagram, suppose we have a water privilege with a flow of 8,300 cubic feet per minute and a fall of 20 feet: the ordinate intersecting the junction of the cubic feet and feet fall lines represents 235 available horse-power. This checks with the calculation by the formula. If the flow had been 83,000 cubic feet instead of 8,300 or if the fall had been 200 feet instead of 20, the available horse-power would have been ten times as great, or 2,350. In this manner, practically, all possible combinations of flow and fall can be applied to the diagram.



THE STROWGER AUTOMATIC TELEPHONE EXCHANGE.

WITH a view to providing a means whereby telephonic connections at the central office may be made electrically without the assistance of an operator, Mr. Almon B. Strowger, of Chicago, Ill., has devised the arrangement shown in the accompanying illustrations.

In Mr. Strowger's system the same general plan is adopted as in that now in use, in having a central station and a number of sub-stations placed in electrical connection with each other at the central office by line-wires, but differs in having an additional series of wires to operate the mechanism at the central office. At the sub-stations are the appliances which are used to transmit and receive communication, while at the central office are arranged as many switch-cylinders, with their attendant mechanisms, as there are sub-stations. From each line-wire "connectives" extend to the inside of each cylinder, there being as many connectives attached to each line-wire as there are sub-stations.

In the accompanying illustrations, Fig. 1 represents the system in perspective, showing at a distant sub-station one telephone and its exchange device at the central office and also the main-line-wires connecting the central office with the sub-station. Fig. 2 represents four of such devices, showing the manner in which the cylinders are connected, and Fig. 3 is a plan view of a series of cylinders, line-wires and connectives, showing the normal position of the circuit. Fig. 4 is a sectional view of the cylinders, showing more clearly the construction of the circuit-closer and feather-and-groove attachment.

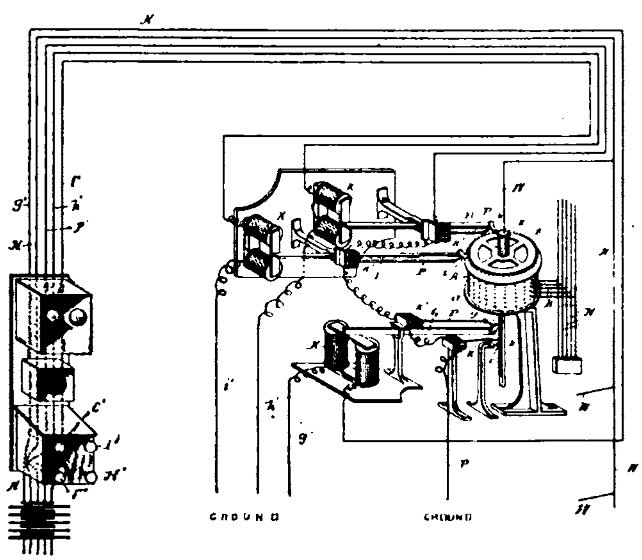


FIG. 1.

As will be seen, a hollow glass cylinder, A, is provided with perforations, *a*, arranged in transverse and vertical rows. The wire connections B extend from the inside of this cylinder through the perforations, and are attached to the main-line-wires N. The function of these connections is to conduct the current to any desired sub-station when brought in contact with a circuit-closing needle C C′. The terminals of these connections are shown at *b*, Fig. 4. Here the circuit-closing arm is represented in parts. Within the sleeve C is closely fitted the circuit-closing needle C′, held in such a manner as to be in perfect electrical contact with the wire-terminal *b* by the spring *c*. The rod D, Fig. 4, is placed along the axle-line of the cylinder and is free to rotate and move longitudinally. The lower end of the rod D has a sleeve into which is inserted the upper portion of the ratched-rod D′. This sleeve construction between the rods allows the ratchet-rod to have a longitudinal motion only and keeps the ratchet-teeth *d* continuously toward their attendant pawl.

The ratchet-rod is provided outside of and below the

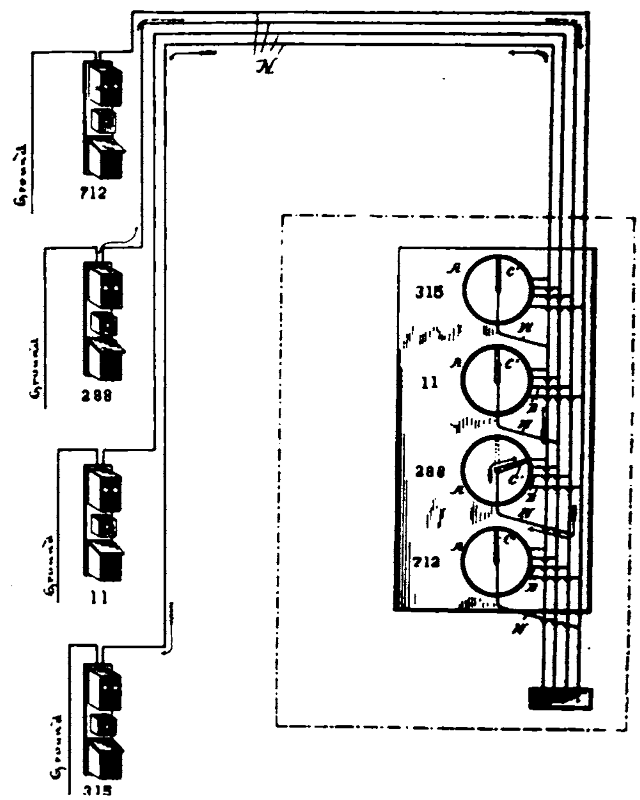


FIG. 2.

cylinder A with a series of ratchet-teeth *d*, by means of which both rods are moved longitudinally. The wheels E and E′, through the hub of which the rod D extends with a feather-and-groove connection, R, Fig. 4, so as to cause the rotation of the rod D and at the same time admit of its longitudinal sliding movement, are provided on their peripheries with a series of ratchet-teeth by which the rod is rotated, and with it the circuit-closer C and C′.

The levers G H I have pawls *g h i* pivoted in their ends in position to engage the ratchet-teeth, with which they are in contact. Each lever has a vibratory movement and is oscillated by the alternate energizing and de-energizing of its respective magnet. At each pulsation of the push-button at the sub-station the needle C′ moves from row to row and from wire to wire in the row. At each sub-sta-

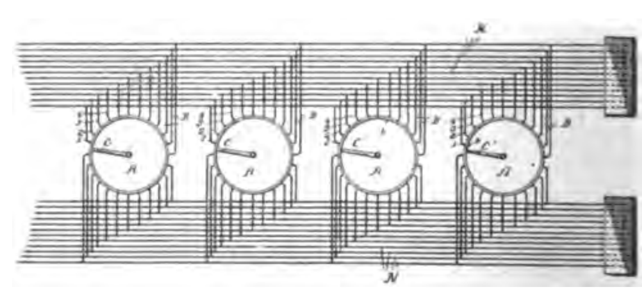


FIG. 3.

tion there is a set of keys marked, respectively, G′, H′, I′ and P′. Each key is connected by wire with its respective lettered magnet at the central office.

Each perforation *a* of the cylinder A is numbered with respect to an initial or starting point on the cylinder—for example, in rows numbered 1 2 3 4, etc.—from the lower end of the cylinders upward and by places in each row—as, for example, 1 2 3 4, etc.—to the right or left of a given vertical row; so that, supposing there were one hundred perforations in each of the rows, No. 310 would be in the third row from the bottom, ten spaces to the right or left of the vertical initial line.

The operation will now be clearly understood. The person wishing to place his transmitter in connection with that of another, will do so by successively pressing the keys which move the circuit-closer C C′. For example, if telephone 288 wishes to place himself in connection with telephone 315 he does so by pressing the key marked G′ three times, then the key marked H′ once, and then the key marked I′ five times. His circuit-closer is then in contact with wire-terminal No. 315. In Fig. 2 sub-station No. 288 is represented as being in connection with sub-station No. 315. This is known by the positions of the circuit-closer of cylinder No. 288.

Had its circuit-closer been turned to the next wire indicated in the figure, 288 would be in connection with 11. When conversation is ended, the person calling up hangs

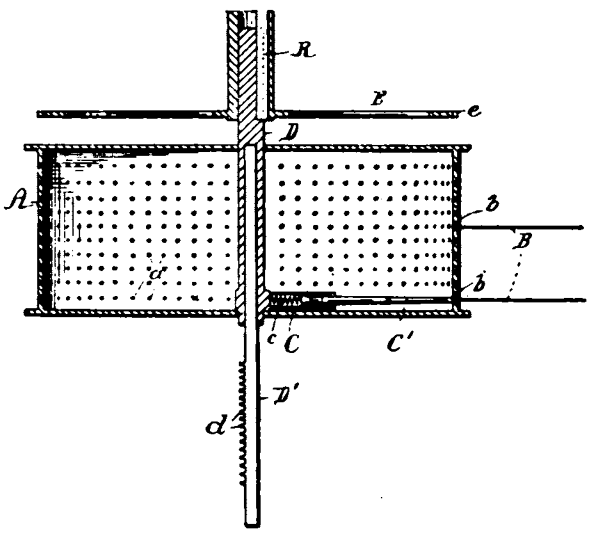


FIG. 4.

up his earphone, depresses the key marked F′, which causes the magnets K to be energized, withdrawing the several pawls from their engagement with the ratchet-teeth and allowing the circuit-closer to fall and return to its initial point.

TOMMASI'S MULTITUBULAR STORAGE BATTERY.

IN a recent issue, we gave a brief description of a new type of storage battery designed by M. Donato Tommasi, of Paris. Since then the inventor has introduced several improvements, having in mind specially the arrangement to obtain solidity and simplicity of construction, and long life. Each electrode is composed of a perforated tube of lead, ebonite, porcelain or celluloid, the bottom of which is closed by a plate of ebonite, in the centre of which is fixed a rod of lead, which acts as a conductor. The space between the central rod and the walls of the tube-electrode is filled with the oxide of lead. Metallic contacts connect respectively the rods of the positive tubes with the rods of the negative tubes, so that the current, in order to pass from one to the other, is obliged to spread over the entire active mass and thus produce a chemical circuit without loss and with uniform action throughout the active material.

The tubular electrode from which the best results have been obtained is in the form of a rectangular cylinder, as shown in the accompanying illustration, Fig. 1, and in this form of the central lead rod is provided with a number of wing-like projections. Special precautions are, of course, taken to prevent the coming in contact of electrodes of different polarity. As a result of this arrangement, the active matter, and hence the capacity of the cell, is greatly increased, and its weight is said to be from two to six times

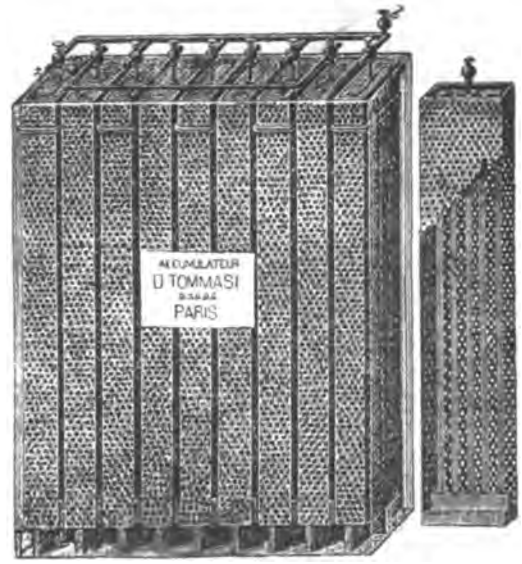


FIG. 1.—TOMMASI'S MULTITUBULAR STORAGE BATTERY.

less, and its volume four to eight times less, than that of the accumulators at present in use. M. Tommasi also claims that in forming or charging his multitubular battery a current of 60 amperes per kilogramme of electrode may be employed, as against one ampere employed in present practice. On account, also, of the absence of allsoldered joints in the connections between the different elements, all interruptions in service are prevented. This type of cell also is free from expansion of the tube, and the active matter, being entirely enclosed, does not fall, and hence a short circuit cannot take place. The illustration, Fig. 2, shows a set of these cells connected up for work. The Tommasi accumulator includes 67 per cent. of active matter, the ratio of active matter to that of lead in weight being about 2.1 to 1; that is, for 100 grammes of lead there are 210 grammes of active matter. The following tables give the principal electrical details of the cell: E. M. F., 2.4 volts; capacity per kilogram of electrode, 16 ampere

FIG. 2.—TOMMASI'S MULTITUBULAR STORAGE BATTERY.

hours; current efficiency, 95 per cent.; watt efficiency, 80 per cent. Mr. Tommasi has also undertaken the manufacture of light tubes, such as celluloid or ebonite, which also tend to reduce the weight of the cell still more.

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VOL. XII. NEW YORK, NOVEMBER 18, 1891. No. 185.

I do not perceive that a mathematical mind, simply as such, has any advantage over an equally acute mind, not mathematical, in perceiving the nature and power of a natural principle of action. It cannot of itself introduce the knowledge of any new principle.—Faraday.

MR. EDISON'S ELECTRIC RAILWAY.

AFTER the occurrences of the past five or six weeks, who will be inclined to deny the hold that Mr. Edison has on the public imagination? However much some may have doubted it before, they now know that his utterances on electricity catch the public ear and eye irresistibly, as do those of no other man, and that what he says is caught up and echoed and amplified in most exaggerated forms; while should there be any great problem that people would like settled offhand between meals, the difficulties are at once referred to him as to a kind of universal inventor simply waiting for hard questions to be put at him so that the solution may at once be given.

Whether we like it or whether we don't, the public will go on this way, choosing its heroes and crediting them with all manner of ability and power. That is one side of the matter. The other side is the responsibility resting on the man thus picked out for such proud preëminence. Here, perhaps, ground may fairly be found for some of the sharp criticisms lately made against Mr. Edison for his statements as to electric railroading. Mr. Edison to-day is unfortunately just as free and unconfined in the expression of his hopes and beliefs and opinions as when he was a humble operator; and he is just as fond of turning over in his mind all sorts of extraordinary projects as the day when he made his first invention. The result is that, knowing how eager the public is to see anything he has said, the "bright and breezy" newspapers of the day are everlastingly interviewing him. They look upon him as a nickel-in-the-slot machine; they drop in a reporter whenever they feel like it, and take out a full-page talk on any subject they want him to enlarge upon. The trouble with these reporters is that few of them, even when highly educated, as most are, know where the statement of fact ends and the discussion of theory and possibilities begins. Few of them are informed on electricity and mechanics, and probably still fewer of them are aware that Julian Hawthorne once said that if Mr. Edison would quit inventing and go in for fiction, he would make one of the greatest novelists this country ever saw.

And this brings us to the recent scare in electric railway circles over one or two of Mr. Edison's late remarks on what might be done with electricity in traction work beyond what had already been accomplished. The public knows that Mr. Edison has made a few inventions that render his name immortal, and, therefore, aided by various reports in the papers, has at once jumped to the conclusion that his optimistic prophecies and boyishly vigorous belittling of difficulties point to actual achievements rather than to something which is yet to be. They know that electricians are constantly predicting the arrival of a time when the steam roads of the country will be operated by electricity, and therefore when their Colossus of electrical inventors thinks aloud that he is "getting there," that settles it. He is there!

We took occasion lately to deprecate the wild newspaper talk on this matter, but it has seemed to us that we might go further and explain with some definiteness just what it was that Mr. Edison had been working at. So far all the talk in electrical and lay papers has been aimless, because no authoritative statement had been made that could be depended upon. We now publish in this issue a very full and clear statement of Mr. Edison's work, and while for obvious reasons as to patents the article does not go into the minute details of construction, enough is said to show that Mr. Edison has attacked a well-defined problem in a well-defined way, and has reached some well-defined results. It is also clear that for the present the trolley system will be left in undisturbed possession of an enormous field. How it could be otherwise with direct current we fail to see. But we do believe that at no distant date, with the alternating current, which Mr. Edison thus far for some occult reason has let severely alone, electrical engineers will find a way of operating long roads and of abolishing the now indispensable overhead wire. In the meantime, and as we have said before, if Mr. Edison has furnished one more means of operating roads electrically, it is universal cause not for complaint, but for congratulation. Every electrical engineer must have regretted seeing the recent heavy investments in cable roads on Broadway and Third Avenue in this city, and will therefore be quick to welcome any new method that shall make such roads electrical, while avoiding the various objections to which electric and cable methods have hitherto been open, when applied to heavy city work.

PAYING LOADS FOR STATIONS.

"Does electrical distribution pay?" In answer to this question it may safely be asserted that where the business has been in the hands of competent and conscientious managers, and where there has been fair capitalization, it is paying, and paying well. The experience which is now available as the result of ten years of active work ought to be a sufficient guide to the station manager, and if his own experience is not adequate, the means for supplementing it are now at hand. We are confirmed in these views in perusing the able paper read by Prof. W. D. Marks, supervising engineer and general manager of the Edison Electric Light Company of Philadelphia, before the recent Edison Convention in this city. In this paper, entitled "How to Get Paying Loads of Stations," Prof. Marks states that his station was started about two years ago, with the price per lamp hour fixed at $1\frac{1}{8}$ cent, which would be the equivalent of gas at $2.25 per M. As gas was selling at $1.50 per M in Philadelphia, the company had to acknowledge that electricity cost more than gas and that it was a luxury. The deterrent effect of such an admission became so apparent that after a few months the price was reduced to $\frac{3}{4}$ cent per lamp hour, thus placing it on a par with the cost of gas. With the cost the same, and with the acknowledged superiority of electricity, the result was not long in making itself manifest.

On the vexed question as to who should undertake the wiring and who should pay for it, it is interesting to note the course pursued by Prof. Marks. His company did no free wiring, but at first furnished service, meter and lamps free of charge. At the end of a year's trial of this system, they furnished only the meter free, and the consumer paid for service and the first installation of lamps; and they still renew lamps free of charge, when not broken. The company preferred also not to do house wiring, and encouraged the establishment of wiring firms by the payment of 15 cents premium for all lights secured, with the result that thirteen wiring firms are now engaged in this business in Philadelphia, all working according to the rules, and under the inspection, of the company. In the same way Prof. Marks encouraged the establishment of agencies of the various motor companies, with the result that no less than nineteen motor firms are represented in Philadelphia. These, together with the wiring firms, constitute no fewer than thirty-two active canvassing agents, who make a profit if they secure customers for the Philadelphia company, but who receive no salary whatever. The company sells power for all 110 volt motors at lamp rates; for 220 volt motors the rate is $7\frac{1}{2}$ cents per horse-power hour. If a consumer takes more than 1,000 horse-power hours, and less than 1,500, the price is fixed at $75 per month; all power above $1,500 is sold at five cents per horse-power hour. Prof. Marks also points out in his paper that motors which run during the day, say from 7 A. M. to 6 P. M., are advantageous as giving the machinery of the station a uniform load, but in winter, when the lighting begins at 4.30 P. M., they overlap the lighting load, making a maximum load occurring between 5 and 6 P. M., and sometimes a very high maximum as compared with the average load. Small factories, business houses, stores and buildings used for offices, closing at 6 P. M., all add largely to this maximum load without burning on an average more than $1\frac{1}{2}$ hours in 24, and for this reason should not form too large a proportion of the station load. With 55,064 lamps connected each lamp yields a gross income of $51\frac{4}{10}$ cents per lamp per month, or $1\frac{71}{100}$ cent per day, the average burning of each lamp being $2\frac{56}{100}$ hours, giving an average selling price of $\frac{668}{1000}$ cent per lamp hour.

PIONEERS IN MULTIPHASE CURRENT WORK.

The attention which the electrical transmission of power between Frankfort and Lauffen has served to call to the multiphase current motor, has led some of our London contemporaries, in their recent issues, to cast doubts upon the utility of this type of motor, and in a witty and caustic editorial the London *Electrician* goes so far as to characterize "the whirling of the three-phase armature at Frankfort as, in more senses than one, a *tour de force*."

To this animadversion Mr. Gisbert Kapp replies at some length, and takes our contemporary to task for thus attempting to throw obstacles in the way of deserving pioneers, who ought to be encouraged in their work.

The editorial of our contemporary has also called forth a letter from Mr. C. E. L. Brown, late electrical engineer of the Oerlikon Works, in which he points out some chronological errors into which our contemporary has fallen. Thus he says:

> "In your article on 'multiphase currents' I find that you are overlooking some of Tesla's patents. This inventor describes quite clearly in his patents from '87 to '88 the three-phase current as applied at Frankfort; and the only novelties which this (Frankfort) Exhibition brings to light are important constructive improvements in its application."

This brings out, in a striking manner, the position occupied by Mr. Tesla in this field, and is a strong confirmation of our recent editorial relative to Mr. Tesla's early work in alternating current motors with two-phase and multiphase currents.

If any further testimony were required on this point, we need only cite a letter by Prof. George Forbes, appearing in the last issue of the *Electrician*, from which we quote as follows:

> "I was also anxious to support the claims of Tesla secured by his twenty-five American patents on this subject, and the practical results of whose work I have examined and tested in America, though they are little known here. I had a remarkable proof of the necessity in all fairness of doing so, for one of the greatest electrical authorities confessed to me yesterday his ignorance of the fact that the dynamo used with Tesla's motors generated separate currents of distinct phases."

Prof. Forbes here states what we have long known to be a fact, viz., that many otherwise well-informed electrical engineers are almost totally ignorant of the principles involved in the construction of rotary field alternating motors. Under such conditions it is not to be wondered at that impressions have gone abroad and statements have appeared that time alone can set right. Mr. Tesla need not be anxious for his fame. We only hope that he may speedily secure also the substantial and tangible justice that every meritorious inventor is entitled to look for.

THE LOCALIZATION AND REMEDY OF TROUBLES IN DYNAMOS OR MOTORS.—VIII.

BY

Francis B. Crocker and S. S. Wheeler.

DYNAMO FAILS TO GENERATE.

This class of troubles is, of course, confined to dynamos and corresponds somewhat to the previous class for motors. This trouble is almost always caused by the inability of the machine to sufficiently "excite" or "build up" its own field magnetism. The starting of a dynamo requires a certain amount of residual magnetism, which must be increased to full strength by the current generated in the machine itself.

1. Cause.—*Reversed residual magnetism,* due to (*a*) reversed current through field coils, (*b*) reversed connections, (*c*) earth's magnetism, (*d*) proximity of another dynamo, (*e*) brushes not in an effective position.

Symptom.—Little or no magnetic attraction when pole-pieces are tested with piece of iron.

Magnetism weaker when machine is running and field circuit closed than when machine is stopped or field open, because current generated tends to build *down,* as it were, or neutralize the magnetism.

Remedy.—Send a magnetizing current from another machine or battery through field coils, then start and try machine; if this fails, apply the current in the opposite direction and try machine again.

Reverse field and armature with respect to each other, *i. e.,* reverse connections of either one or shift brushes.

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2. Cause.—*Too weak residual magnetism.* Symptoms and remedies of this trouble are substantially the same as in the previous case, but the attraction for a piece of iron is even weaker—in fact, practically nothing.

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3. Cause.—*Short circuit in the machine or external circuit.*

This applies to a shunt-wound machine, and has the effect of preventing the voltage and the field magnetism from building up.

Symptom.—Magnetism weak, but still quite perceptible.

Remedy.—If short circuit is in the external circuit, the opening of the latter will allow the dynamo to build up and generate full voltage. If the short circuit is within the machine, it should be found by careful inspection or testing. In either of these cases do not connect the external circuit till short circuit is found and corrected.

A slight short circuit, such as that caused by a defective lamp socket or copper dust on the commutator, may prevent magnetism from building up.

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4. Cause.—*Field coils opposed to each other.*

Symptom.—If pole-pieces are approached with a compass or other freely suspended magnet, they both attract the same end of the magnet, showing them both to be of the same, instead of opposite, polarity.

For similar reasons the pole-pieces are quite strongly magnetic when tested separately with a piece of iron, but show less attraction when the same piece of iron is applied to both pole-pieces at once, whereas the attraction should be much stronger. In multipolar machines these tests should be applied to consecutive pole-pieces.

Remedy.—Reverse the connections of one of the coils, so that the polarity of the pole-pieces is opposite and not the same.

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5. Cause.—*Open circuit.*

(*a*) Broken wire or faulty connection in machine, (*b*) brushes not in contact with commutator, (*c*) safety fuse melted or absent, (*d*) switch open, (*e*) external circuit open.

Symptom.—If the trouble is merely due to the switch or external circuit being open, the magnetism will be at full strength, and the machine itself may be working perfectly, but if the trouble is in the machine, the field magnetism will probably be very weak.

Remedy.—Make very careful examination for opening in circuit; if not found, test separately the field coils, armature, etc., for continuity with magneto or cell of battery and electric bell. (See Instructions for Testing.)

CONCLUSION.

It is obviously difficult, if not impossible, in the treatment of dynamo and motor troubles to give complete directions for locating or identifying all the various troubles, but in most of the cases this will be found possible; and moreover it is a fact that a mere list of these troubles, particularly if it is systematically arranged, is of the greatest help in overcoming these difficulties. It is in the promptness and intelligence with which such troubles are dealt with that the ability or inability of a man is most clearly shown.

PRELIMINARY NOTE ON A METHOD FOR DETERMINING THE PERIODIC CURVES OF ALTERNATING CURRENTS.

BY

Louis Duncan.

(Johns Hopkins University.)

THE experimental methods heretofore used for the determination of current and electromotive force curves in alternating circuits present many difficulties and are cumbersome and tiresome. Most of those now in use are based on the experiments of Joubert, who obtained the E. M. F. curve of a De Meritens dynamo by making instantaneous contacts between the dynamo circuit and measuring circuit at different points on the E. M. F. curve. This method was modified by Messrs. Wilkes, Hutchinson and myself[1] to give curves of primary and secondary E. M. F. and current in alternating circuits containing transformers, condensers, etc. Our method has been copied by Prof. Ryan and others, and the results which we obtained some years ago have been duplicated and extended. M. Blondlot has

1. *The Electrical World,* March, et seq., 1888. It is a mistake to imagine that any special electrometer is needed for this method; an ordinary Thomson quadrant electrometer was used in our work and our measurements were apparently made as easily as those of later experiments.

recently still further modified the method by using a galvanometer through which a condenser, charged to a potential representing different points on E. M. F. curves, is discharged, the deflections being photographed. By using two contact-making arrangements or wipers, with two galvanometers, two curves were obtained at the same time.

The difficulties of most of these methods lie in the very considerable potentials used on the commutators—as much as 1,500 volts in some experiments—the fact that only one curve can be obtained for each commutator; with the possibility of error due to the contacts.

The following method is simpler and gives better results: To get the four curves representing the primary and secondary E. M. F.'s and currents, four small dynamometers are made and their stationary coils wound for primary current, primary E. M. F., secondary current and secondary E. M. F., respectively, their movable coils being connected in series in circuit with a few storage or other cells; this latter circuit having one end connected with a contact point on the dynamo shaft, the other end connected to a wiper touching the contact point at each revolution. The wiper is movable through the arc of a circle (180° is sufficient if the curves are not to be photographed). These dynamometers may be cheaply and quickly made with wooden spools and a quartz fibre suspension, the current being carried by pieces of coiled tinsel or fine wire as in a d'Arsonval galvanometer. Four of them may be easily made in a day.

In making the experiments the deflections of the dynamometers are either observed or photographed. It is evident that if the instantaneous current in a movable coil occurs when the current in the stationary coil is zero, there will be no deflection; if the latter current is at its maximum, the deflection will be a maximum; while for intermediate values the deflection (I am considering small deflections, of course) will be proportional to the instantaneous value of the current in the stationary coils. By moving the wiper through 180° uniformly, if we are photographing, we get all of our curves simultaneously, without the possibility of changed conditions changing their relative values. A galvanometer in circuit with the movable coils allows an absolute scale to be applied to the curves, after the dynamometers have been once calibrated, and eliminates any error caused by the wiper. We are thus able to obtain any number of curves simultaneously with only one commutator, with only a few volts on this commutator, and with no possibility of errors due to the contacts.

FIRE HAZARDS FROM ELECTRICITY.[1]—I.

BY C. J. H. WOODBURY.

ONE of the many innovations arising from the introduction of electric lighting has been the development of a new feature in underwriting, which is the beginning of methods of practice which will in time greatly modify systems of insurance.

There have been two methods of dealing with questions involving the insurance of elements of unusual hazard: the one being that of underwriting pure and simple, estimating the hazard from the best data at hand, and charging a rate commensurate with that risk,—the correct principle being that the hazard of the whole is equal to the greatest hazard of any part of the risk.

The other method has consisted in eliminating the hazard of the more dangerous parts by removing such processes to another building, or at least placing them in a portion of a building where the chances of their imperiling the whole would be controlled by special methods of construction and also by additional fire apparatus, or, in other words, bringing the hazard to conform to the rate of insurance.

The latter method is confined to class insurance of such limited range that the detailed supervision of risks can be within the personal scope of the administration of such insurance companies.

When electricity was first used for lighting on a commercial scale, no small part of the knowledge gained of phenomena was the fact that it became a frequent cause of fire, and in such unexpected ways that a general alarm ensued, which would have stopped its use if electric lighting had not so completely filled a need for more light that a prohibition was out of the question. Electricity had come to stay, and the problem of its status must be met and not evaded.

Those whose familiarity with electrical lighting appliances is only that of to-day, with every element of the apparatus established in commercial affairs, can have but little appreciation of the condition of such matters a little over ten years ago.

Everything was new, crude and undeveloped. The leading inventors were pursuing their investigations under great difficulties, not the least of which was the lack of trained assistants. Mechanics had much to learn in the construction of the apparatus; the proper manufacturing supplies were not in the market; and the steam engines especially designed for operating dynamos had not been made. The development of the whole business required invention, education and organization from one end to the other.

Electric lighting then pertained to apparatus for the physical laboratory; now it is one of the great commercial features in the business world, reaching in all its applications in the United States to investments estimated by Lieut. Allen R. Foote, special agent United States Census, to be $232,202,850, out of a total of $552,202,850 invested in electrical enterprises, and divided as follows: Telegraph companies, $125,000,000; telephone companies, $100,000,000; isolated lighting plants, $6,000,000; central station plants, $155,202,850; electric railways, $70,000,000; fire alarm and police patrol, $10,000,000; steamboat plants, $1,000,000; sundry industries, $10,000,000; manufactures, $75,000,000.

The introduction of electric lighting in this country was followed by numerous fires caused by this new method of illumination. After the disturbance incident to the first scare, careful investigations were made into the subject, the greatest result of which was the establishment of the opinion that the elements of excessive hazard were not necessarily inherent in such applications of electricity. In other words, such fires were to be classed as preventable fires within the limits of ordinary practical means; and on this basis the rules for electrical installations were first prepared, only to be followed by other rules, drawn up by various parties, to apply to new conditions for the use of electricity for the transmission of power and alternating currents, as well as to improvements in both arc and incandescent lighting.

The electric lighting interests have always, and without exception, co-operated with the underwriters in these investigations, which, indeed, could not have reached to successful results had it not been for the indispensable services afforded by the skill of those engaged in this manufacture.

The results have fully justified the means, for electricity is today the safest method of artificial illumination. This safety is not due to the absence of possibilities of danger, but to the entirety with which these elements of danger may be held in control, and also the elimination of the hazards inherent to lighting by either gas or oil.

The essentials of safety consist in confining the electricity to its metallic circuits, the prevention of undue arcs in switches and lamps, and the prevention of sparks or carbons falling from arc lamps; but in their applications these precautions are necessarily involved in order to meet all of the complex conditions of the apparatus used in the various applications of dynamo currents.

The danger of fire from dynamo currents is almost entirely due to the diversion of a portion of the electricity from the system, and to the fact that the miscellaneous conductors forming these outside circuits are not adequate to convey the current without undue and dangerous heating. Moisture on an otherwise poor conductor generally plays an important part in such conversions of electricity into heat, because the small trickling of water is readily dissociated, and then the resistance at the place is increased to a sufficient amount to cause the electricity to be converted into heat of sufficient temperature to ignite any combustible material in its path.

Rain-water, or that from ponds used for a public water supply, is a rather poor conductor, but in passing over whitewash it takes enough salt and lime solution to become a very fair conductor, and the same applies to water used in washing floors.

About ten years ago I made some experiments upon this matter for the purpose of investigating into the conditions of two fires caused by arc lighting circuits.

From the binding posts of an arc lighting dynamo with forty lights in circuit, two wires about six feet in length were secured, one foot apart upon a broad board, thus providing the greatest difference of potential in the circuit, amounting to about two thousand volts, in a place where it was convenient for experiment. The board was washed with a clean mop wet with pure water, but without producing any effect. Then a little salt was thrown into the water, and the water was rapidly dissociated and evaporated, and the board set on fire, not merely on its surface, but well into its interior.

These matters are cited in advance of their proper place for the purpose of presenting the importance of protecting a system in buildings from exposure to water, and also the urgency of keeping the system free from electrical connection from the earth; for

1. A lecture delivered at Cornell University, Nov. 6, 1891.

while it is a rare coincidence that a single conductor should connect two wires of opposite polarity, yet, if one ground exists, any second connection to earth will establish an outside circuit.

A few months ago an electric lighting wire chafed against an automatic sprinkler pipe until the insulation was worn by the abrasion. The first ground already existing at some other part of the system completed a circuit, and the heat of the arc was sufficient to melt a hole in the pipe, although it was full of water.

It should be remembered that when a single arc is formed it can be blown out as readily as the flame of a candle. This is seen in the air jets used to break the arcs on the commutator of a Thomson-Houston dynamo of the squirrel-cage pattern. In the lightning arresters of the same system, the arc being dia-magnetic, it is broken by the repulsion of an electro magnet.

I wish to submit to you some of the principal considerations covering the several conditions of installations, presenting what should be considered as a consensus of the opinions of underwriters and electricians who have made a specialty of questions pertaining to the fire hazard of electricity, and these opinions are mainly based upon the experience of actual fires, or experiments in which conditions of possible hazard have been simulated.

Dynamos, generators, and motors should be considered as machines rather than merely as electrical apparatus. The shafts of the armature should be provided with journals well suited to maintaining free lubrication and to run without undue heating. The oil pans should be arranged so as to prevent any oil from being spilled on the floor, and moreover, the oil should be drawn from these pans so frequently as to prevent any accumulation of oil therein.

The dynamo should rest upon substantial foundations adequate to keep it from jarring, and if used to generate currents at a tension of over 350 volts, there should be a space under the floor, as that is about the only means of preventing the attendants from receiving severe shocks if there should be a ground on the circuit.

Dynamos should be protected from exposure to water, and for this reason it is generally unadvisable to place automatic sprinklers over a dynamo-room, as a discharge of water from any of these might cause a great deal of injury. Each dynamo should be provided with a waterproof cover, which is to be placed over it when not in use.

The use of motors and dynamos for trolley systems of street car propulsion introduces special features which must be provided for. In the present state of the art, the single trolley wire with a return current through the earth is the only feasible means of operating an electric system of street car propulsion; and the question of the extra hazard of the motors must be met by placing the generators in special buildings, and thoroughly protecting the system of overhead wires by suitable guard wires.

The reason why the double-trolley wire system is not practically effective is due to matters pertaining to mechanical questions, such as the difficulty in arranging switches, and also the necessary complexity of the double trolley in comparison with the single trolley.

The single-trolley system is not advocated, as has been alleged, on account of any economy of copper wire, because in order to insure ground returns of low resistance, copper wires are buried between the tracks the whole length of the line and connected to each rail by branch wires riveted to the web and soldered to the buried wire.

One of the more recent applications of electricity for illumination is the use of alternating currents in connection with transformers or converters. This apparatus should be situated in a secure place outside of the buildings, except in case of underground service, when the converter may be put in any convenient place that is dry and does not open into the interior of the building.

Converters should be equipped with safety fuses at the junctions of all feeders and mains, and furthermore, the wires of the secondary circuit should be protected against the current of the primary circuit from reaching the interior of the building by the use of air or film cut-outs connected with both poles of the wires of the secondary circuit near to the converters, in order that if there should be any direct electrical conductivity from the primary to the secondary circuit, the primary circuit would be grounded at once. These cut-outs are generally adjusted to operate whenever the current reaches a potential of 350 volts.

It is not desirable to permanently ground one of the wires of the secondary circuit, because in such case the wires have the same fire hazard as if the circuit was furnished with electricity from a dynamo, which would be diverted from the system whenever a second ground occurred; and it should also be borne in mind that the alternating currents tax an insulation more severely than a continuous or even pulsating current, and that as a practical matter the primary circuits of an alternating system conveying currents of high potential are almost always grounded.

Switchboards are a frequent cause of fire, because at these points are concentrated most of the extreme differences of potential due to the system, and arcs are frequently formed in the ordinary use of the switchboards. A switchboard should not be placed against a hollow partition or in any other place where it might readily communicate fire to the building. Thus far, slate appears to be the preferable material for the construction of such switchboards, but when such switchboards conduct currents of high potential there is a slight leakage across slate, and it is necessary that the holes should be bushed with hard rubber or other material. Switchboards should not be made in any event of plain wood surfaces, but whenever the circumstances are such that it is not practicable to use an incombustible material, an open skeleton of wood will best serve the purpose.

Whenever resistance boxes or equalizers are placed, precautions should be taken for the prevention of any accident in case they should become heated. Most of the frames of such apparatus are now made of metal, and asbestos paper is placed behind them if they are secured near to wood.

The lightning arresters should be connected to the earth outside of the building, and gas pipes should not be used in such connections. Water pipes are the best base to which to attach wires from lightning arresters.

The matter of outside wires cannot be adjusted on the basis of the electric principles involved, because the numerous difficulties arising from other features of the subject render the question still an unsettled problem. The wires for the most part are either over buildings not lighted by electricity, whose occupants, not being patrons of the lighting company, have no interest in the functions of these wires; or the wires are carried on the poles along the streets, where their status pertains to the rights of the general public to the unobstructed use of the highway. These qustions have not been settled, and will not be settled until there is found a way to settle them.

The matter is not helped by any such enactment as that passed by one of the States several years ago, to the effect that all wires should be underground before November 1, 1885, or to similar ordinances passed by numerous municipalities during the last six or eight years.

It is not surprising that there should be a general opposition to overhead wires, of such a widespread and determined nature that they would have been placed underground years ago had there been any means which were feasible in every respect. The only reason for this suffrance of overhead wires has been the fact that the uses of electricity have been essential to the needs of the community.

Underground wires are no new thing. In fact, they preceded aerial wires, and nearly strangled the invention of the telegraph; for when the first line was being laid in 1843 between Baltimore and Washington along the line of the Baltimore and Ohio Railway, subject to the conditional consent of the board of directors that "the wires should be removed in case that the electric fluid caused any injury to the property of the company," the wires, as a part of Prof. Morse's invention, were covered with an insulation placed in lead pipes, and for nine miles from Baltimore to Relay Station, laid underground by means of a special plough invented by Ezra Cornell. This line did not work, and Ezra Cornell made the invention which expanded the telegraph from an apparatus to a system, by placing the wires overhead attached to insulators at points of support.

Since that time ingenious inventors have endeavored to devise methods for running the wires underground, without producing anything financially practical except to a limited extent, and not feasible in any event except in densely populated localities where the patronage is sufficient to meet the excessive expense. All must recognize the great work of Edison in his invention of an underground system adapted to his system of incandescent lighting.

One of the pioneer efforts to devise an underground system fitted to American practice in arc lighting was that of Prof. W. A. Anthony, who laid wires under the Campus at Cornell University in 1878, but I have been informed that this did not stand the test of the deteriorating influences of time and the drain layer's pick.

The fall of a pole is always a misfortune, and may be a disaster. In all events it is an occurence to be avoided, and I believe that in cities it will be found a wise precaution to use wood treated by some of the antiseptic processes, or to substitute tubular iron masts for wood poles in accordance with the best American practice for supporting trolley wires.

WORLD'S FAIR NOTES.

At a meeting of the committee on electricity, electrical and pneumatic appliances, of the World's Columbian Exposition, held October 26th, the following names were decided upon as those of eminent electricians not now living to be placed over the Electricity Building at the Exposition:

Franklin, Galvani, Ampere, Faraday, Ohm, Sturgeon, Morse, Siemens, Davy, Volta, Henry, Oersted, Coulomb, Ronald, Page, Weber, Gilbert, Davenport, Soemmering, Don Silva, Arago, Daniell, Jacobi, Wheatstone. Gauss, Vail, Bain, De la Rive, Joule, Saussure, Cooke, Varley, Steinheil, Göericke, La Place, Channing, Priestley, Maxwell, Coxe, Thales, Cavendish.

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, *150 Broadway, New York city.*

HUMAN COOKERY.

YOUR remarks as to the experiments that Dr. Southwick proposes to inaugurate to ascertain how much the electric current will cook or burn human beings and animals, recalls the statement I used to read when I was a boy, in *Fox's Book of Martyrs*, illustrated by a cut representing one of them on a gridiron being broiled alive over a slow fire. The author represents the victim as saying to his tormentors:

"This side enough is toasted,
Then turn me, tyrant, and eat,
See whether raw or roasted
I am the better meat."

As the electric current renders speech impossible, of course we shall have no such heroic utterances, though it is not unreasonable to imagine that such thoughts may occupy the mind in advance of its application.

Personally, I have no objection to the use of electricity for executing criminals, even though it should raise a blister, for that certainly is far less cruel than the scenes witnessed not infrequently at hangings, and is nothing like so repulsive as the bloody beheadings by the guillotine or the headman's axe.

The question in which the public is mainly interested is the certainty that crime will be punished and not so much how the punishment shall be inflicted, though of course the less barbarous and revolting the better.

No thoughtful person can doubt that the great prevalence of violent crime in this country is due to *the uncertainty of its punishment*, the chances being three to one, if not more, in favor of the escape of the criminal from any punishment. That, however, is the fault of the courts, our played-out jury system, and the efforts of the criminal lawyers, who, for money, become parties to the crime after its commission by their clients, and who I consider but little, if any, less guilty than the principals.

W. C. DODGE.

WASHINGTON, Nov. 11, 1891.

Literature.

Central Station Management and Finance. By H. A. Foster. New York, *C. C. Shelley*, 1891. Paper, 50 pages. Illustrated. $1; cloth, $1.50.

THE series of articles contributed to the columns of THE ELECTRICAL ENGINEER during the present year by Mr. Foster have now been put together in book form. We are glad to know that the articles have met with very cordial approval from authorities on the special subject, and that the book has already been adopted for use in some of the collegiate courses in electrical engineering. A station superintendent or electrical engineer who has thoroughly mastered Mr. Foster's scheme of organization and accounts—and it is not at all difficult—will find his work very much improved in efficiency, and the margin of profit greatly increased. Not a little of the value of the book lies in its reproductions of the various forms, tables, blanks, etc., which are recommended for use. As the first and only book on the subject, this treatise by Mr. Foster will enjoy a large sale.

How to Make Inventions. By E. P. Thompson. New York, *D. Van Nostrand Co.*, 1891. Paper, 161 pages; price, $1.

THIS is a unique book. Probably nobody but Mr. Thompson himself could have written it, for very few men combine with industry and ability the experience gained as mechanical engineer, electrical engineer, chemist, professor, editor, expert, lecturer, inventor, and patent attorney. It is a cross between Smiles' *Self-Help*, a manual on physics and a patentee's guide; and while the mixture may seem incongruous, we can only say that the result is a book of intensely interesting character. It is a volume to be put in the hands of every ardent student or ambitious young inventor, and we do not believe anybody can read it without being in some way benefited. Many of its hints—and there are thousands of them—are most valuable, for Mr. Thompson often goes so far that he leaves little to be done by the inventor of the actual apparatus which shall embody his suggestions. Here and there Mr. Thompson makes a most useful survey of the work done in certain fields, and shows why some paths are hopeful, while others cannot possibly lead to success. Chapter IX, for example, on the principles involved in light and heat as tools for inventions, is an extraordinary example of pith and point; and Chapter XII, dealing with chemistry, is almost as good. Chapter XXIII, suggesting some problems still to be worked out, provides not a little food for thought, and shows Mr. Thompson to be a very keen observer of the drift of invention. It is a funny thing, but nevertheless a fact, that inventors tail after each other like so many sheep. One of them hits on a new idea, and then five hundred other fellows pitch in, and the consequence is that there is an awful amount of reinventing and wasted work in duplication of hopeless experiments. Mr. Thompson brings out the fact very clearly that there is a New World for every man if he have but courage, perseverance and genius—these three, and principally the first two. We note few mistakes in the book. One is the statement that Frank J. Sprague was in the army. Mr. Sprague is one of the numerous exiles from the navy.

Electricity Simplified. By. T. O'Conor Sloane, E. M., Ph. D. New York, *Norman W. Henley & Co.*, 1891. Cloth, illustrated, 158 pages; price, $1.

THIS is an excellent little book, well worth perusal. The keynote is touched in the preface, when the author says: "A theory which is far from complete has been constructed by modern scientists, and may eventually acquire perfect shape. The hypothetical luminiferous ether is at its base. The probable identity of species of electromagnetic and light and heat waves gives us an additional right to use the ether in explaining these manifestations of electricity." Developed along these lines, we get a very forcible treatment of the whole subject; and, at the same time, the book is practical in the best sense of the word. The author is to be commended for the careful subdivision and grouping of his matter and for the complete index.

Society and Club Notes.

NEW YORK ELECTRIC CLUB—GOVERNMENT TELEGRAPHS.

THE New York Electric Club will have the pleasure, within a month, of listening to a lecture by Mr. E. Rosewater, editor of the *Omaha Bee*, a leading Republican newspaper of the West, on Government Telegraphs. This gentleman has recently returned from Europe, where he has been studying the subject in behalf of our own Government and of Postmaster-General Wanamaker. He is himself a strong advocate of national control of the telegraphs, and has accumulated a large amount of data on all sides of this question, which is destined to become a big political issue sooner or later. Mr. Rosewater has had exceptional qualifications for his investigation, being himself an old telegrapher. He is now president of the Old Time Telegraphers' Association. The Entertainment Committee of the club expect that the meeting will be one of the most fully attended of the season, and are already being pressed for invitations, the subject being one of very important social and political, not less than electrical, bearings. The club is to be congratulated on having before it an authority who will thus make public some of the results of his European mission.

THE FRANKFORT ELECTRICAL EXHIBITION BEFORE THE INSTITUTE AND ELECTRIC CLUB.

AT a joint meeting of the American Institute of Electrical Engineers and the Electric Club, to be held at the clubhouse, 17 East Twenty-second street, Tuesday evening, November 24, Dr. Carl Hering will present a paper entitled "Notes on the Frankfort Electrical Exhibition," illustrated with lantern slides. Dr. Hering was chairman of the delegation of the American Institute of Electrical Engineers to the Electrical Congress, and was given every facility to investigate thoroughly all departments in the Exhibition. To those who were not able to visit Frankfort this occasion will afford the best possible opportunity for obtaining full information from an intelligent and expert observer.

Through the courtesy of the officers of the Electric Club, the privileges of the house will be extended to all members and guests of the Institute who may present the usual notice of meeting issued by the secretary.

NEW YORK ELECRICAL SOCIETY.

A SPECIAL feature of the New York Electrical Society is that it is composed of peripatetic philosophers. In other words, it makes a point of visiting as many places of electrical interest as possible, and its members have thus enjoyed some rare and most delightful opportunities. Another of these occasions will be furnished this week, on Thursday, at 8 P. M., when, through the kindness of the Fire Commissioners and of Mr. J. Elliot Smith, the superintendent of fire-alarm telegraphs, the Society will make a thorough inspection of the fire headquarters at 157 East Sixty-seventh street, and see how the alarm apparatus works. Every New Yorker is proud of the efficiency of the city's fire service, and there is no doubt that there will be a big crowd of members at the headquarters that night.

CHICAGO ELECTRIC CLUB.

MR. W. P. SULLIVAN has resigned the managership of the Chicago Electric Club, which position he has ably filled for the past year. This step will be regretted by the members, amongst whom he has a host of warm friends, who appreciate his unfailing courtesy and attention while in charge of the club.

THE THOMSON SCIENTIFIC CLUB.

AT a meeting of the above club at their rooms in Lynn on Thursday evening, Nov. 5, a very interesting paper was read by Mr. Caryl D. Haskins on "Electric Meters." Mr. Haskins is quite a veteran in the field of electric meters, having been in that line of work for a number of years. He was with Ferranti in England and has latterly been engaged in meter work in this country. He described the growth of the meter to its present state of perfection, when we find meters on the market that record the consumption of electric energy with surprising accuracy. Various types of clock, motor and photographic meters were exhibited.

The club's public lecture course began on Wednesday, Nov. 11. The first lecture was delivered by Prof. Thomson. The other lecturers are as follows: Prof. Chas. P. Cross, Mass. Inst. of Tech.; Rev. Dr. J. M. Pullman, of Lynn; Prof. A. E. Dolbear, of Tuft's College; Prof. Helen L. Webster, Wellesley College; Prof. Wm. A. Anthony, of Manchester, Conn.

Legal Notes.

ELECTRIC ANNUNCIATORS FOR ELEVATORS—WESTERN ELECTRIC COMPANY vs. ELECTRICAL CONSTRUCTION CO. AND G. A. HARTER.

ON November 9, Judge Blodgett, of the U. S. Circuit Court, Northern District of Illinois, rendered a decision imposing a fine of $50 and costs upon the Electrical Construction Company and Gustav A. Harter for infringement of the patent of Elisha Gray, No. 173,998, granted February 1, 1876. An injunction was ordered in the same court in January last restraining the defendants from infringement of patent No. 148,447, March 10, 1874, to Augustus Hahl, as well as of the Gray patent above noted. The Hahl patent covered the use of a flexible cable. The Gray patent covered "the combination of a movable elevator car, the annunciator attached thereto and moving therewith, circuit-closing and breaking signal-keys on different floors, and mechanism whereby an electric current is maintained between the signal-keys and annunciator without interruption by the movement of the car." Both patents had previously been before the same court and held valid. Proofs showed that defendants had directly infringed the Gray patent in May last by putting an electrical annunciator in an elevator at the Haymarket Theatre in Chicago. Meantime the Hahl patent had expired in March. The court held that the expiration of the Hahl patent did not affect the merits of the case as regards the Gray patent, which has still a considerable period to run.

EDISON GENERAL COMPANY vs. H. T. PAISTE ELECTRIC LAMP SOCKETS.

A BILL in equity has been filed in the United States Circuit Court, Philadelphia, by the Edison Company against Henry T. Paiste, of Westchester, Pa., complaining of an alleged infringement by the defendant on patented improvements in sockets or holders for electric lamps.

GOD FORBID!

ONE of the attractions of the Chicago Exhibition is to be a pyramid of 400 pianos connected by electricity and manipulated by one woman.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED OCT. 27, 1891.

Accumulators:—

Secondary Battery Electrode, J. B. Entz and W. A. Phillips, 461,823. Filed Oct. 31, 1890.
Electrode is made up of wire bent upon itself and forming a mat or plate; wire loops or straps surround the plate.

Secondary Battery, M. Waddell and J. B. Entz, 461,858. Filed Oct. 31, 1890.
Claim 1 follows:
In a secondary battery, the combination of a positive and negative electrode, one contained within the other and one being entirely covered or protected with insulating material.

Dynamos and Motors:—

Electric Generator, C. G. Young, 461,862. Filed April 25, 1889.
An alternating-current dynamo.

Dynamo Electric Machine or Motor, M. Mayer, 461,979. Filed May 5, 1891.
Relates to design and methods of construction, with a view to cheapness.

Automatic Regulator for Dynamo Electric Machines, W. L. Silvey, 462,030. Filed July 5. 1889.
Employs a solenoid and a liquid resistance.

Galvanic and Thermo-Electric Batteries:—

Galvanic Battery, C. N. Souther, 461,965. Filed March 28, 1891.

Lamps and Appurtenances:—

Incandescent Electric Lamp Socket, C. P. Poole, 461,898. Filed March 5, 1891.

Rheostat for Electric Lamps, T. A. Lacey, 462,058. Filed May 5, 1891.

Metal Working:

Method of Welding or Working Metals Electrically, C. L. Coffin, 462,207. Filed Dec. 22, 1890.
The material to be heated is connected with one pole of a generator and is placed in contact with a conductor in proximity to the point of contact between such conductor and a second conductor, which latter is connected with the other pole of a generator; the heating current passes through the material and the conductors and the material is heated not only directly by the current, but also by the heat developed at the point of contact between the two conductors.

Miscellaneous:—

Electric Heater, J. V. Capek, 461,814. Filed Oct. 30, 1890.
The heating conductor is in the form of a volute spiral, the several turns being separated and covered by insulating material; an impervious casing surrounds the conductor.

Electric Connection, J. H. Fleming, 461,868. Filed Jan. 9, 1891.
A wire-joint.

Lightning Arrester, E. W. Van Brunt & W. M. Raynor, 461,991. Filed May 16, 1891.

Circuit-Controller, W. B. Cleveland, 462,088. Filed June 17, 1891.
For cutting out a portion of a light or power circuit in case of emergency.

Railways and Appliances:—

Electric Car-Brake, La M. C. Atwood, 461,808. Filed Jan. 10, 1891.
Employs a motor for actuating the brake.

Signaling System, F. P. Benjamin, 461,809. Filed Feb. 9, 1889.
Enables a car in motion or at rest to signal other trains on the same track.

Signaling System, F. P. Benjamin, 461,810. Filed Apr. 19, 1889.
For signaling between trains by inductive effects.

Trolley for Electric Cars, C. A. Lieb, 461,840. Filed Mar. 23, 1891.

System of Distribution for Electric Railways, S. H. Short, 461,851. Filed Jan. 4, 1890.
Claim 1 follows:
In a system of electrical distribution for electric railways, the combination, with an electric generator and a continuous trolley line or conductor, of a trolley line consisting of a series of insulated sections, an individual conductor connecting each of said sections with the generator, and an automatic cut-out for opening the circuit on the passage of an abnormally heavy current included in each one of said connecting conductors.

Electric Railway, W. B. Vansize, 461,969. Filed Sept. 1, 1890.
A combination of a storage-battery supply with a trolley and central station system; includes an arrangement of sectional conductors and a series of storage-battery outfits along the line, at each section.

Electric Railway, G. W. McNear, 462,014. Filed Oct. 11, 1889.
Relates to contact devices and the insulation of conductors.

Electric Railway Switch, H. C. Spaulding, 462,082. Filed Sept. 26, 1890.

Underground System for Electric Railways, S. D. Nesmith, 462,158. Filed Aug. 4, 1890.
Claim 3 follows:
In an electric railway, the combination of a conduit having sluiceway, drainage, a longitudinal plate arranged diagonally within said conduit and electric conductor supported beneath said plate, and a trolley-arm adapted to slide on said conductor, and provided with a branch arm, substantially as and for the purpose specified.

Electric Railway, C. W. Thomas, 462,177. Filed May 6, 1890.
An underground system employing a sealed conduit or tunnel for both outgoing and returning conductors with contact devices at short intervals.

Electric Railway Trolley, R. M. Hunter, 462,219. Filed July 1, 1891.

Telephones and Apparatus:—

Multiple System for Telephone-Exchanges, W. E. McKivitt, 461,887. Filed Mar. 30, 1885.
Relates to switchboard connections.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED NOVEMBER 3, 1891.

Accumulators:—

Secondary Battery, J. H. Palmer, 462,449. Filed Jan. 3, 1891.
Plate is formed of laminated pillars connected together by metallic bars; the pillars are composed of thin pieces of lead or other material separated by interposing parts or projections.

Alarms and Signals:—

Electric Signaling System, F. B. Wood, 462,345. Filed Jan. 6, 1890.
Adapted for a central and sub-station and provides for operating sub-stations individually or collectively.

Electric Alarm Bell, C. A. Hale, 462,381. Filed June 5, 1891.

Conductors, Conduits and Insulators:—

Method of and Apparatus for Constructing Electric Light or Other Lines, H. Lemp, 462,263. Filed March 30, 1891.
Relates to splicing or jointing conductors. Employs electric heating; employs the current traversing the conductors to be spliced or joined for heating purposes.

Electric Wire Support Bracket, O. B. Hall, 462,315. Filed Aug. 6, 1891.

Conductor for Three-Wire Systems, E. H. Johnson, 462,489. Filed Sept. 2, 1891.
A cable having three conductors, one surrounding the other two, the outer conductor being connected to the neutral wire of the system.

Cross-Tree for Suspended Electric Wires, J. Levy, 462,564. Filed Aug. 7, 1881.

Threading Rod for Underground Conduits, F. G. Bolles, 462,648. Filed Sept. 8, 1891.

Distribution:—

Method of and Apparatus for Electrical Conversion and Distribution, N. Tesla, 462,418. Filed Feb. 4, 1891.
Claim 1 follows:
The method of the electrical conversion herein described, which consists in charging a condenser or conductor possessing capacity and maintaining a succession of intermittent or oscillating disruptive discharges of said conductor into a working circuit containing translating devices.

System of Electric Lighting, F. M. Garland, 462,311. Filed Sept. 9, 1890.
Adapted to lighting railway cars or similar vehicles. Employs the rotation of the axle of one pair of wheels to drive a dynamo.

Dynamos and Motors:—

Gearing for Electromagnetic Motors, C. E. Chinnock, 462,348. Filed Aug. 26, 1890.

Controlling Device for Electric Motors, F. O. Blackwell, 462,369. Filed July 13, 1889.
Claim 1 follows:
The combination, with an electric motor, of a current-controller and circuit-reverser therefor, a common actuator positively actuating both, but allowing the controller a predetermined amount of lost movement relative to the reverser.

Commutator Brush, F. O. Blackwell, 462,466. Filed March 5, 1889.

Lamps and Appurtenances:—

Electric Lighting System, J. I. Conklin, 462,237. Filed Feb. 9, 1891.
Combines the use of dynamos and storage batteries.

Incandescent Lamp, E. Thomson, 462,338. Filed Dec. 27, 1886.
Provides for the automatic completion of circuit in case of the rupture of the incandescing conductor of the lamp.

Incandescent Lamp, E. Thomson, 462,339. Filed Mar. 12, 1887.
A thermostatic device for shunting or short-circuiting a lamp in case of rupture of the incandescing conductor.

Electric Lighting Apparatus, H. B. Meech, 462,444. Filed Nov. 24, 1890.
Employs a series of electric lamps contained in an outer enclosing globe, the whole rotating together.

Covering for the Bulbs or Globes of Electric or other Lamps, A. Duval and H. Nelson, 462,477. Filed May 13, 1890.

Incandescent Electric Lamp, T. A. Edison, 462,540. Filed Mar. 25, 1889.
Designed to prolong the period of efficient candle-power. Relates to the process of preparing the filament. After the lamp is exhausted the filament is heated to a red heat, or to a heat much below its normal incandescence temperature.

Electric Lamp Cover and Switch, E. T. Mueller, 462,571. Filed Apr. 30, 1891.

Key Socket for Double Filament Incandescent Lamps, W. J. McCutcheon, Jr., 462,574. Filed June 18, 1891.

Electric Arc Lamp, T. Conroy, 462,624. Filed Feb. 16, 1891.
An arc lamp for employment on incandescent circuits.

Electric Arc Lamp, F. H. Carpenter, 462,660. Filed May 1, 1891.
Relates to the mechanism of a disc carbon lamp.

Electric Arc Lamp, F. H. Carpenter, 462,661. Filed May 7, 1891.
Relates to the frame of lamp and globe supporter.

Carbon Holder for Electric Arc Lamps, H. E. Chapman, 462,662. Filed May 1, 1891.
Relates to disc carbon lamps of the kind described in the patent of E. C. Russell, July 15, 1890, No. 432,284.

Pencil Carbon Holder for Electric Lamps, H. E. Chapman, 462,663. Filed May 7, 1891.

Stay for Suspended Electric Lights, F. A. Johnson, 462,669. Filed July 21, 1888.

Electric Arc Lamp, E. C. Russell, 462,673. Filed May 21, 1891.
Improvements in disc carbon lamps of the class described in the same inventor's patent, 432,284, July 15, 1890.

Incandescent Lamp Socket, T. J. Fay, 462,677. Filed Jan. 22, 1891.

Measurement:—

Electric Current Meter, J. W. T. Olan, 462,504. Filed Apr. 16, 1891.
Claim 1 follows:
The combination, in an electrical meter, of a needle or pointer, a coil or magnet for moving it, through which the current to be measured passes, a plate over which the needle moves in a regular arc, a record sheet between the plate and the needle, mechanism for advancing the sheet, and means operating through the needle while it is out of contact with the sheet for marking on the sheet the position of the needle.

Metallurgical:—

Electromagnetic Separator, R. R. Moffatt, 462,321. Filed Jan. 20, 1891.

Electromagnetic Separator, R. R. Moffatt, 462,322. Filed Feb. 2, 1891.

Amalgamating and Extracting Gold from Refractory or other Ores, W. Crookes, 462,535. Filed Jan. 10, 1891.
Consists in submitting the ore to the combined action of a solution of a mercurial salt and an alternating electric current.

Metal-Working:—

Automatic Electric Welding Machine, H. Lemp & C. G. Anderson, 462,261. Filed Feb. 2. 1891.
Relates to devices for manipulating the objects to be operated upon.

Laminated Die, Hammer, etc., for Electric Metal Working Apparatus, H. Lemp, 462,262. Filed Feb. 24, 1891.

Miscellaneous:—

Ceiling Block, A. Ekstrom, 462,349. Filed May 29, 1891.

Electric Switch, M. Hoopes, 462,353. Filed Aug. 4, 1891.

Electric Gate, H. Gillette, 462,403. Filed Dec. 10, 1890.

Electric Switch, R. M. Hunter, 462,407. Filed May 22, 1891.

Electric Fuse Cut-out, E. W. Rice, Jr., 462,452. Filed Oct. 18, 1890.

Switch and Cut-Out Device, H. P. Ball. 462,463. Filed Mar. 23, 1891.

Electric Elevator, H. H. Blades & W. J. McKee, 462,527. Filed Jan. 11, 1890.
Employs rack-bars at the sides of the well, gearing engaging the rack-bars to the armature shaft; circuit switch located on the elevator; a running rope extends from the top to the bottom of the well and is connected with the switch on the car, enabling a person on any floor to operate the switch and start the car up or down.

Electric Cooking-Stove, J. V. Capek, 462,532. Filed Dec. 15, 1890.

Electric Hair-Brush, A. Stanton, 462,599. Filed Aug. 3, 1891.

Railways and Appliances:—

Automatic Signal Apparatus, J. B. Stewart, 462,518. Filed Dec. 23, 1890.
Relates to railway block-signals.

Electric Railway, E. M. Bentley, 462,231. Filed Nov. 23, 1888.
A conduit system; trolleys or brushes under-running the conductor or conductors in the conduit.

Clamp for Trolley-Wires, C. A. Lieb, 462,359. Filed July 28, 1891.

Trolley for Electric Cars, R. D. Nuttall, 462,578. Filed June 19, 1891.

Electric Railway, J. B. Sheldon and D. J. Murnane, 462,595. Filed Feb. 12, 1891.
Employs a series of yieldingly-secured rotating switches in the conduit and having connection with a source of electricity and devices on the motor car.

Conduit Electric Railway, A. J. Robertson, 462,672. Filed Dec. 10, 1890.
Employs an open duct or receiver extending longitudinally along the track-rails and provided with insulation for a main conductor, which latter is a slack, naked wire which is under-run by a trolley projecting below the car; the conductor rising out of the duct and falling back as the car moves along.

THE NEW DOWN-TOWN EDISON STATION.

The station of the Edison Electric Illuminating Co., now being built at the corner of Pearl and Elm streets, this city, comprises many ideas which are entirely new in this field. Its capacity will be 30,000 h. p., the engines being of the vertical four-crank quadruple expansion type, with an initial pressure of from 210 to 220 pounds. These engines, it is said, will be of 5,000 h. p. each. A model 1,000 h. p. engine of the same type is being built by the Dixon Company for the Twenty-sixth street Edison station. This engine occupies only 92 square feet of floor space, exclusive of the overhang of the shaft.

The boilers of the new station will be of the water-tube type and will probably be internally fired. This latter point, however, has not been definitely settled. The system for collecting the radiant heat and returning it to the furnace is peculiar to this station. The doors and windows will be kept closed, and a constant supply of fresh air forced into the building at its lowest level. This air during its passage upward accumulates heat from engines, machinery and piping, and then is made to flow over the boilers and through a piping gallery and an arrangement of pipes in the chimney flue, being finally discharged into the ash-pits and over the grates in the proportion of 80 and 20 per cent. respectively, at a temperature of about 300 degrees.

The steam mains will be of copper and will be run in rows, no single pipe being larger than 8 inches in diameter. Each pipe will be wound with steel wire for its entire length and corrugated into the flanges, no brazed joints being used.

This system, which we have only briefly touched upon, is the result of the deep study and extended observation of Mr. John Van Vleck, chief electrician of the Edison Electric Illuminating Co. of New York, who promises to reduce the consumption of coal to one pound per h. p. per hour. This, if accomplished, will result in a saving for this one station of the interest on nearly a million dollars. We are indebted to Mr. Van Vleck for these very interesting details.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Effective advertising is a large element in business success.

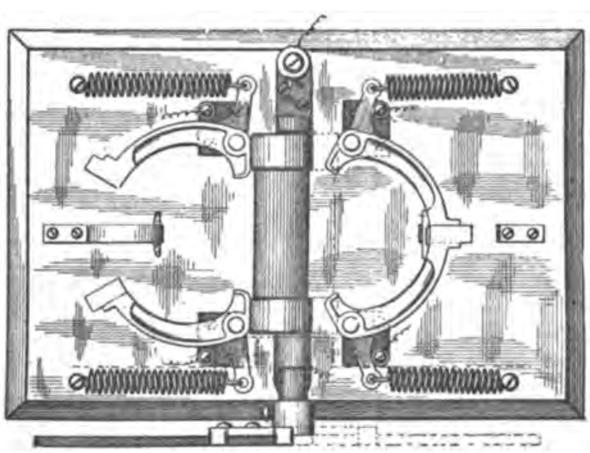
CROCKER-WHEELER.

THE Crocker-Wheeler Electric Motor Company have a large exhibit of their perfected motors and dynamos at the Industrial Exposition to be held in Augusta, Ga., from Nov. 2d to Nov. 28th. Mr. George C. Field, of that company, is now in Augusta arranging their exhibit, and will shortly be joined by Mr. George W. La Rue, general sales agent, who is now on a tour through the South visiting the many agencies of the Crocker-Wheeler Company in that section of the country.

The Crocker-Wheeler Electric Motor Company have, by the way, found it necessary to very much increase their facilities in order to keep up with the large demand for their popular goods. They have recently furnished a 3 h. p. motor of their popular perfected type to run a large church organ in Ottawa, Ont. Other late installations of note are a 5 h. p. special dynamo to the Cornell Electric Company, Hamilton, Ohio; one hundred and twenty-five 1/8 h. p. and six 1/4 h. p. 10 ampere arc motors to a well-known firm in Baltimore, Md.; one 1 h. p. to the Alabama Polytechnic Institute, Auburn, Ala., and 1 h. p. to the Berlin Dry Goods Store, Brooklyn, N. Y., to run a cash carrier system, besides very heavy shipments to the West Indies and other foreign countries for the Thomson-Houston International Electric Company, Boston, Mass.

THE VAN NORT TRANSFER SWITCH.

IN the operation of electric motors on constant-current circuits it often becomes necessary to transfer the motor from the day or regular power circuit to one of the night or regular arc light



VAN NORT TRANSFER SWITCH.

circuits. This would be the case when power is wanted during the night after the regular power circuit has shut down. The accompanying engraving illustrates the Van Nort transfer switch for making such a tranfer. The motor is connected to two metallic rings upon an insulated eccentric shaft, the connection being effected by means of the bearings in which the shaft rotates, each bearing being provided with a binding post to which the terminals of the motors are connected. The eccentric is rotatable by means of the handle. The two supply circuits are connected respectively to the two circuit breakers.

In the position shown in the cut, the handle being thrown to the left, the motor is placed in connection with the left-hand circuit; throwing the handle to the right transfers the motor to the right-hand circuit. The circuit-breaking levers have a wide throw at their break ends, so as to break the arc, and a central piece placed near their contacts also serves to split or divide the arc. Continuity of the supply circuits is maintained at all times. The break points do not separate until after the eccentrics have connected the motor thereto, and in switching off the break points make connection with each other before the motor is disconnected, the motor being put on short circuit for an instant in either operation. This switch has just been patented by Van Nort Bros., No. 515 Walnut street, St. Louis, and is being placed on the market by them.

BARTLETT & CO.

A GREAT many readers of THE ELECTRICAL ENGINEER will be interested to learn that a reorganization, so to speak, has been effected in the above well-known firm, with the object of greatly enlarging and extending its business. As a firm of engravers, it stands certainly at the very head of the craft, and having long made a specialty of mechanical and electrical apparatus, it has won and long enjoyed a reputation of which any concern might be proud. The best wood-cuts appearing in electrical journals are its product, while in the publication of artistic catalogues for electrical companies it has never been equaled. The new company will continue this work, but will add a number of new departments in the higher branches of engraving and printing. Mr. E. E. Bartlett will be its artist and Mr. Theo. von der Lühe its chief engraver, and these two gentlemen have done so much to raise the standard of art work in illustrating electrical appliances and plants that we can only wish for them as much business in their newer field as they have already enjoyed in the old. With them will be associated Mr. L. H. Orr, in charge of the fine art printing. Mr. Orr is a practical printer, familiar with all the details of typographical work, and has had a large experience in very responsible capacities with some of the largest establishments in the East. The business will be carried on at the "new central station."

THE CLARK SEARCH-LIGHT.

THE Clark arc lamp now being exhibited at the American Institute Fair by the Clark Electric Co., of 192 Broadway, is made especially for search-light purposes. It is attracting a great deal of attention and is of great interest to those interested in navigation. It is mounted on swiveled trunnions and can instantly be turned to throw light in any direction. Mr. Ernest P. Clark, the inventor of this lamp, illustrated the operation by revolving it and placing it in every conceivable position. The lamp burned steadily and uniformly during all the various movements. There are no flexible cables used, all connections being made through the trunnions by means of insulated joints.

As there are no cords or weights used in the construction of this lamp, and as its action is entirely independent of the effects of gravity, it will work as freely on a vessel in a heavy sea as on land.

It is the object of the Clark Electric Co. to place on the market the most reliable and durable search-light for every purpose yet known, and their exhibit has attracted considerable attention.

CARBORUNDUM.

THE Carborundum Company, of Monongahela City, Pa., have succeeded in producing a substance which has been proved a perfect substitute for bort. Carborundum, as this substance is called, is of a beautiful crystaline structure, the octahedron formation predominating. The crystals are transparent, and of a variety of colors. Carborundum, it is said, is not affected by any reagent, and remains permanent at high temperatures. In hardness it is 10 on Mohr's scale, being equal to the diamond. Its qualities are such, in fact, that may with propriety be called manufactured diamond powder. The company have recently issued a most attractive little folder containing a number of flattering testimonials. Mr. E. G. Acheson is prominently connected with the company.

BALL ENGINE CO.

J. W. PARKER & Co., 38 South Fourth street, Philadelphia, report the following sales, within a month, of the Ball engine: Thomson-Houston Electric Co., Boston, Mass., one 250 h. p. compound condensing engine for electric railway duty at Brockton, Mass.; Johnstown Electric Light Co., Johnstown, Pa., one 200 h. p. standard engine for electric lighting; Columbia Electric Co., Philadelphia, Pa., one 200 h. p. standard engine for electric lighting; Lock Haven Electric Light and Gas Co., Lock Haven, Pa., one 150 h. p. standard engine for electric lighting; Sauquoit Silk Mills, Scranton, Pa. one 35 h. p. standard engine.

MANHATTAN ELECTRICAL SUPPLY CO.'S CATALOGUE.

THE catalogue of the Manhattan Electrical Supply Company, 36 Cortlandt street, is one of the most complete we have ever seen. It is fully illustrated by excellent cuts, descriptions accompanying those whose application is not seen at the first glance. This catalogue contains telegraph instruments and appliances, Mesco and other batteries, burglar alarms, and general electrical supplies. There is a list of electrical books in the back, as well as a set of directions for setting up different kinds of cells.

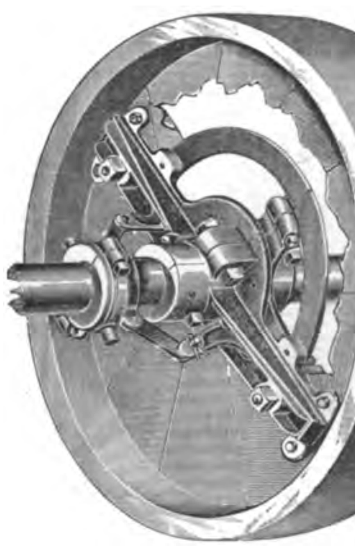
WESTERN ELECTRIC CO.

We have received from the Western Electric Co. the "pocket edition" of their general catalogue of July, 1891. It is a photographic fac-simile of the larger book, and is so neat and clear that it suggests the doubt whether the larger size is, after all, necessary. Catalogues, like journals, gain greatly in appearance by this compactness and refinement in size, and the company is certainly to be congratulated on its Elzevir edition of a standard trade publication, for such its general catalogue became long since.

A NEW "TAPER SLEEVE" FRICTION CLUTCH.

The success with which the clutches of the Taper Sleeve Pulley Works, of Erie, Pa., have met, instead of satisfying the concern, has acted as an incentive to still better work. The light, strong friction clutches of this company, with their segmental wooden webs, and their firm grip and ready release, are already familiar to our readers; their latest piece of enterprise, however, is not yet so well known, and is shown in the accompanying illustration.

The peculiarity of the new clutch lies in the fact that the clutch proper, which is usually keyed to the shaft and revolves with it, even while the pulley is at rest, is in this case fastened to the pulley and stops when the pulley is released. It is believed



New "Taper Sleeve" Friction Clutch.

that this is the only clutch made in which this is the case, and those already installed have given the utmost satisfaction.

THE HOWARD MULTIPLE BALL BEARING.

Experience with ball bearings has shown that, owing to but a small portion of the actual surface being used in contact with the balls, the tracks in which they roll soon become worn. In order to obviate this difficulty, and provide a bearing suitable for very heavy work, ex-Governor Henry Howard, of Providence R. I., who has long been actively interested in mechanical and manufacturing pursuits, has devised the ingenious arrangement shown in the accompanying illustrations.

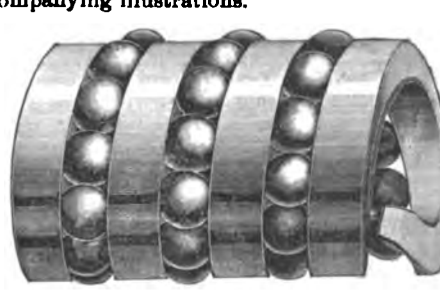


Fig. 1.—Howard Multiple Ball Bearing.

As will be seen in Fig. 1, the balls are held loosely between the coils of a helix, the sides of which are concave, so that they may turn freely, the helix being partly closed at the ends to prevent them from running out. The shell thus made is held in place by collars which prevent any lateral movements, and turns freely as the balls rotate. It will be noticed that, as the balls are placed helically in the shell, and revolve in an annular direction, in planes at right angles to the centre line of the journal, and as the lateral play of the shell is sufficient to cover the pitch of the balls (usually about $\frac{1}{16}$ inch), the entire surface of both shaft and box is utilized. That this is practically, as well as theoretically, true is shown by an inspection of these surfaces after extended use.

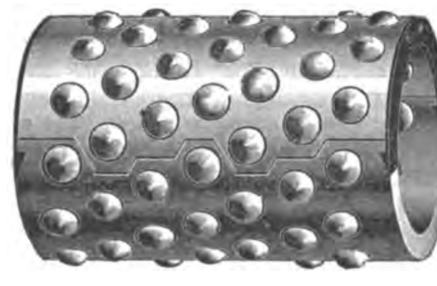
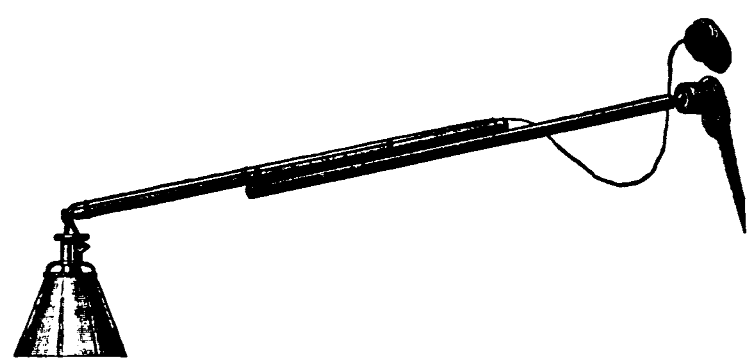


Fig. 2.—Howard Multiple Ball Bearing.

The Howard bearing, shown in Fig. 2, differs from that already described in the form of the shell which holds the balls in holes, placed in a helical line, instead of in a groove. This shell is divided longitudinally, and may be placed upon any part of a shaft without slipping it over the end.

Tests of this bearing have shown very satisfactory results. Our contemporary, the *American Machinist* reports some striking results in reduction of loss by friction, obtained in experiments made by its editor. It seems to us that the Howard bearing should find a very wide application in mechanical and electrical work. These bearings are to be made by the Mossberg Manufacturing Co,. Attleboro, Mass.



Dawes Electric Light Support.

THE DAWES ELECTRIC LIGHT SUPPORT.

The accompanying illustration shows an ingenious device, controlled by Messrs. R. Hollings & Co., of 547 Washington street, Boston, for conveniently holding an incandescent lamp in any position and at any angle. As will be seen, the rod can be lengthened or shortened at will, its range in this instance being from 20 to 36 inches, and will remain at any angle without further adjustment. The lamp is also adjustable at the end of the rod. This same principle is applied to a variety of both wall and ceiling brackets, ranging in length from 6 feet to 20 inches,

THE UNION DRAWN STEEL CO.

An important and promising departure has been made by the above concern, of Beaver Falls, Pa., in securing as Eastern sales agent, Mr. Thomas Towne, well known to the electrical and mechanical trade as buyer for the Garvin Machine Co. The fact that Mr. Towne should engage with the concern, after an intimate acquaintance with the merit of goods in this line, speaks volumes for the excellence of the company's product. The company have made a specialty of cold die rolled steel and iron shafting, piston rods, pump rods, slides and shapes; screw rod; key stock, tongue stock, and gib stock; as well as tool steel for milling machine jaws, etc. Their shafting is remarkably fine and true, with polished surface and machine-cut ends, and is made accurately down to thousandths of an inch with a very slight advance in price for accurate drawing. Mr. Towne is well posted as to the peculiarities of electrical concerns in expecting extreme accuracy in such work, and that is just the line of trade he is on the hunt for. He has established headquarters at 584 Electrical Exchange, Liberty street, and is already actively pushing these goods.

Mr. H. E. Bradford, has been appointed superintendent of the Marlboro, Mass., street railway.

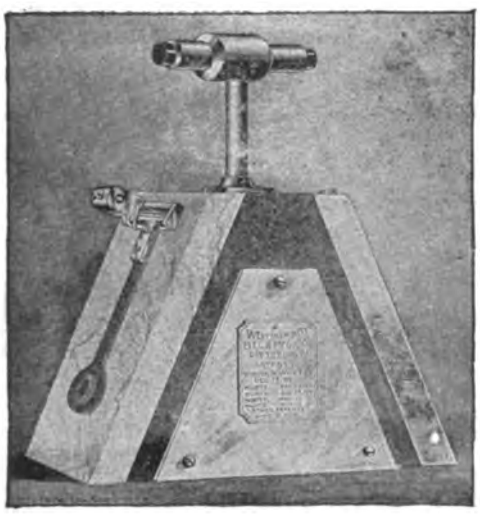
THE NEW WESTINGHOUSE LIGHTNING ARRESTER.

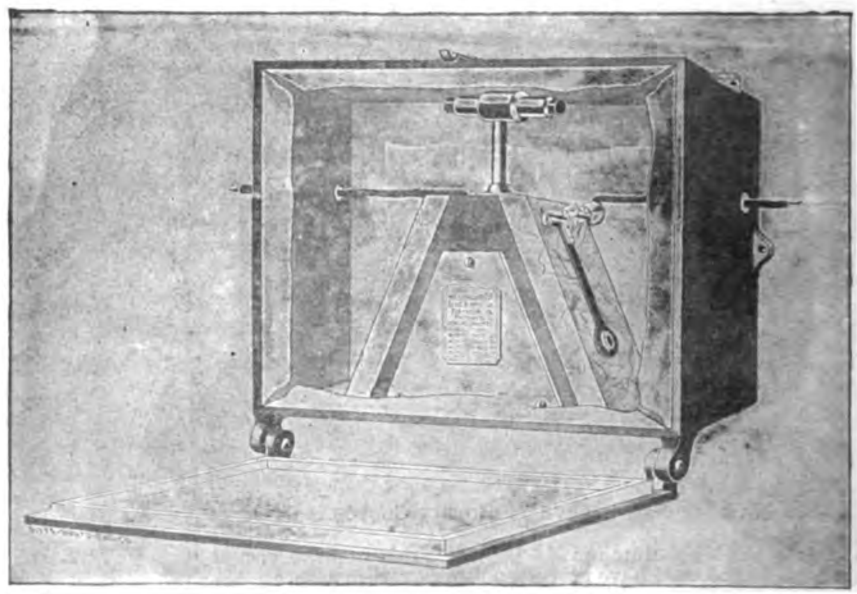
A LIGHTNING arrester to fulfil the purpose for which it is designed must have a very small air-space, across which the discharge has to jump, in order to present as little resistance as possible; be free from any inductive resistance, automatic in its action, simple in construction, and must provide means for surely and quickly destroying the arc which follows the discharge.

All of these conditions are claimed for the Westinghouse lightning arrester, the most improved forms of which are shown in the accompanying illustrations. The operation of this instrument does not depend upon magnetic action. The air-space is adjustable and may be made as small as necessary, and the arrester is entirely automatic. To meet the last of the above-named conditions a very simple principle is utilized. The heat of the arc is made to expand the air in a closed chamber, the only outlets from which are closed by two movable arms. The sudden expansion of the air drives these two arms outward and the arc is at the same time drawn out and blown out. The arms fall back into place by gravity and the arrester is ready for a second discharge. So rapidly is this done that the entire action requires only a small fraction of a second.

The accompanying illustration, Fig. 1, is a view of this lightning arrester as constructed for use on the switchboard at the power station. A triangular iron box, having for two of its sides marble slabs, is mounted on a marble base. Near the upper end of each of these slabs is fastened a small brass casting, part of which serves as a binding post for making connection with the trolley or ground wires. From each of the castings hangs by a hinge a light metal arm which carries at its lower end a carbon point. This point makes contact with a carbon block inside the chamber by passing through a circular hole in the marble. The discharge takes place between two "saw-teeth" carbons inside the chamber, and the arc is first formed at this point, but the air instantly expands and drives out both of the movable arms. The circuit is thus broken in two more places and the rupturing of the arc takes place instantly. By removing the triangular plate of brass on the front of the arrester the carbon points may be examined and adjusted. The "T"-shaped arm which projects from the top of the iron box carries two insulated bumpers, against which the hinged arms strike when blown out.

The form of arrester for use on electric cars is similar to the one described, the only difference being that the arrester proper is placed inside of an asbestos-lined iron box, which thoroughly protects it. A view of a car lightning arrester is given in Fig. 2. As this arrester requires no attention further than an occasional inspection, it may be placed out of sight under the platform of the car. These arresters are suitable for any system of electric railways, and are giving excellent satisfaction.





FIGS. 1 AND 2.—THE NEW WESTINGHOUSE LIGHTNING ARRESTER.

CHANGES IN THE MEXICAN TARIFF.

THE Bureau of American Republics is informed that, in the new Mexican tariff, which went into effect November 1, the following commodities, among others, have been added to the free list: Insulators for telegraph and telephone purposes, batteries and lightning rods.

ELECTRICAL SLATE.

MR. T. J. MURPHY, of 136 Liberty street, has orders for two of the finest slate switchboards ever installed. One of these is for R. H. Macy & Co.'s new building, and the other goes to the Four Seasons Hotel, Cumberland Gap, Tenn. The outside dimensions of the first of these switchboards are 12 feet 2 inches by 8 feet 1 inch. This is built up in seven sections. Four of the sections, each 5 feet long, go at the top of the board, the two outside pieces being 3 feet 1 inch wide, which allows 1 inch for moulding, while the two centre sections are 3 feet wide. Under these centre pieces an open space is left 18 inches high and 6 feet long for the accommodation of rheostats, and under the rheostats, so as to raise them from the floor, is another section of slate 5 feet long and 18 inches high, the whole being finished by two corner pieces each 8 feet high and 3 feet 1 inch wide, the odd 1 inch being for the moulding, which will surround the whole. This slate is highly polished and presents the appearance of marble, being made in imitation of Bardillo. The second switchboard is 8 feet 8 inches wide and 7 feet 5 inches high and is made in three top sections of equal dimensions, each 5 feet high. A space of 15 inches underneath is entirely blank, with the exception of two small pieces at the extreme sides each 2 inches wide to finish the ends, rheostats filling the balance of the space. The bottom is in two sections, each 4 feet 4 inches long and 12 inches high.

The fact that these boards are built up in sections does away with the necessity of cutting a solid piece of slate to make room for the rheostat, and it also makes the shipment of material easier and safer. Another point in their construction is that the rheostats do not project, but are flush with the face of the slate, and all switches are mounted on the board itself, doing away with extra bases, and making an even face on the whole of the apparatus.

The holes for contacts are drilled before shipment, so that the contractor simply places the sections in position.

These installations seem to speak well for the growing demand for marbleized slate in the electrical business. We may add that Mr. C. L. Eidlitz, of 10 West Twenty-third street, has charge of the installation of both the plants above mentioned.

THE JEWELL BELTING CO.

THE Jewell Belting Co., of Hartford, Conn., have been making some very large sales of big driving belts within the last week or two. They report sales aggregating 102 feet of 40-inch three ply, 97 feet of 40-inch double, 241 feet of 36-inch double, 384 feet of 30-inch double, 70 feet of 26-inch three ply, 216 feet 24-inch double, 89 feet of 22-inch double, and 416 feet of 20-inch double, and numerous smaller belts. A good part of this amount is to be used in electric light and power stations.

Their factory is completely equipped for turning out large belts very quickly. As an instance of this it may be stated that one day last week they received an order for two driving belts, one a 36-inch and the other a 30-inch, both double, and on the following day they were on the road to their destination, being completed in twelve hours.

THE ELECTRIC APPLIANCE CO.

The Electric Appliance Company are rapidly filling their capacious store at 242 Madison street, Chicago, with a well-assorted and desirable stock of general electrical supplies, and will very shortly be in a position to meet any demand that can be made upon them in the way of orders.

In addition to putting themselves in shape to do a large country business, they will give special attention to meeting the wants of the city trade. The large and varied experience of the officers of the company in this line, added to their wide acquaintance among Chicago's electricians, will materially aid them in this respect, and is a sufficient guarantee that their facilities for handling this trade will be unexcelled.

They also report having secured several valuable specialties for the Western market, some of which, it is said, will create considerable interest when announced, and fill a long-felt want in their respective lines. Full particulars will be given out as soon as they can get in shape to be ready to meet the demand that will certainly arise upon the announcement.

The work on the offices of the company is being rapidly pushed and matters are beginning to assume a business appearance, and give promise that they will have a perfect arrangement particularly suited to the requirements of their trade.

We are advised by the Electric Appliance Co., of Chicago, as we go to press that they have just closed negotiations for the general Western agency for Paranite wires and cables. This is a new rubber-insulated wire of the highest grade and possessing, it is claimed, merits not found in any other wire now on the market. The insulation is made up of an inner layer of white rubber which is an absolutely pure Para, hence the name of the insulation. This layer of pure Para prevents the slightest corrosion of the wire and at the same time adheres with a wonderful tenacity, preventing any chance of peeling the wire in drawing over rough corners and surfaces. This layer of the insulation is covered with a thick layer of rubber, to which just enough sulphur has been added to permit the vulcanizing process. The whole is then vulcanized, leaving, when the process is completed, an insulation composed of a white, pure Para core and an outer layer of black rubber possessing the highest possible insulating qualities and a wonderful toughness. It is so tough, in fact, that it can only be removed with a sharp knife or edged tool. After being thus prepared the wire is covered with either a tough tape or strong braid, being furnished either taped or braided, as desired.

The manufacturers make very strong claims for their wire, and the Electric Appliance Co. undoubtedly have a very valuable specialty—a wire with which they can compete with anything on the market.

AN INTERESTING TEST.

A most severe, and very interesting test was made last week by Messrs. Wm. Sellers & Co., of Philadelphia, upon a motor operated under the new principle invented by Mr. H. Ward Leonard. The motor used was a 10 h. p. standard shunt-wound Sprague motor. The motor's normal speed was 1,500 revolutions a minute. The motor was belted to a countershaft, and upon the countershaft was placed a brake. In addition to the brake there was placed upon the countershaft a large fly-wheel such as is used upon punching machines, the purpose of the fly-wheel being to supply the inertia and momentum met with in practice in a great many kinds of work.

The motor was made to operate in either direction at any rate of speed desired, and it was found possible to run perfectly and regularly under the full brake load, at 15 revolutions per minute, that is, one per cent. of its full speed. While operating at full speed in one direction, the motor could be instantly reversed, the reversal being perfectly gradual and entirely without any spark or troublesome feature of any kind.

In order to get the most marked effect in overcoming the momentum of the fly-wheel, the brake was taken off, and when the fly-wheel was running at its full speed of 300 revolutions a minute the motor was reversed instantly. In thirteen seconds the motor had brought the fly-wheel to rest, and in thirteen seconds more had it running at full speed in the opposite direction, the entire operation being effected with the greatest smoothness and without any spark whatever.

The performance of the motor was extremely satisfactory to all concerned, and showed its perfect adaptability to any class of work to be met with in practice.

The Porter & Leavitt Electric Motor Co., 82 Laura street, Providence, R. I., are erecting a factory near their present one, which they expect to occupy about December 1st, where with increased facilities they hope to be able to meet their steadily increasing business. They have just filled a large order for fan motors from Hong Kong, China.

THE PENNSYLVANIA ELECTRIC ENGINEERING COMPANY.

This company, engineers and contractors, Penn Mutual Building, Philadelphia, are prepared to submit proposals and specifications for any electric work, and will contract to equip lighting and power stations and isolated plants; furnishing plans for dynamos, power generators, motors, line construction, and inside wiring, and also for buildings, engines, boilers, pumps, etc. They supply to plants already in operation all fittings necessary for their successful maintenance, and have carefully selected from each of the various electrical companies that particular article of manufacture which has merit, irrespective of price, for its recommendation. The president and manager of the company, Mr. Arthur L. Bosley, has been connected with the Heisler Electric Light Co. for the past four years, and prior to that time was with the Edison, Thomson-Houston, and Sawyer-Man companies. He has had ten years experience in the electrical business.

Mr. L. P. Schultz, the secretary and treasurer, has been connected with Mr. C. M. Blanchard, representing the National Electric Manufacturing Co., Germania Electric Co., and Western Electric Co., prior to which time he was secretary and treasurer of the Electric Trust, which comprised the Brush, United States, Thomson-Houston, Excelsior and Underground, and has had about eight years' experience.

The company have sufficient capital to carry out any contract which they undertake.

ELECTRICAL USES OF GRAPHITE.

It is probable that there are many expert electricians who have but a small idea of the important part that graphite, sometimes called plumbago or blacklead, plays in the electrical industry. The Jos. Dixon Crucible Co., Jersey City, N. J., inform us that they make for several electrical companies graphite sticks, varying in resistance from ¼ ohm to 100 ohms to the inch.

The Dixon Company also prepare for laboratory use a graphite 99 per cent. pure, and make to order from drawings sent them any number of curious articles in graphite without having the faintest idea of what their function is to be. Electrical experts are just beginning to realize the manifold uses that graphite in one form or another can be put to.

A. L. IDE & SON.

The list of engine sales made by A. L. Ide & Son since August 1, 1891, is a long and imposing one. It shows sales of some 72 engines of a total of over 7,500 h. p. A large number of these engines have gone to electric light plants and electric railway power houses, while others have been taken for electric mining work.

ST. LOUIS NOTES.

H. H. Humphreys, St. Louis agent of the Edison General Electric Co., has during the past month made the following sales: The *Globe Democrat* Building, 2,000 lights; Central Distillery Co., 200 lights; Beaby Manufacturing Co. 270 lights; The Madison Car Co., Madison, Ill., 160 arc lights; Standard Oil Works, Madison, Ill., 200 lights: Chester, Ill., 1,500 lights; Butler, Mo., 400 incandescent and 35 arc lights; Decatur, Ill., 110 lights. A contract has also been taken for the wiring of the new Security Building for 3,000 lights. The "Interior Conduit" system will be used. The Cupples Building plant of 3,400 lights has been finished and put into successful operation. It ranks among the largest isolated plants in the West.

The Municipal Electric Light and Power Co. have determined to enter the incandescent lighting field and will install a 10,000 light plant in their mammoth arc light station. The Slattery 1,000 volt alternating system will be used. The first part of the installation will consist of two 3,000 and one 1,000 light generator. Others will be added as the demands of business may require. The company are also installing a 500 volt constant potential power circuit. A 250 h. p. Thomson-Houston generator will be put in for this purpose. A Hamilton-Corliss engine of 600 h. p. will be put in to supply power for these additions to the station.

Mr. A. W. Dutton, Southwestern agent for the Brush Electric Light Co. and the Short Electric Railway Co., has just returned from a four months' trip in the Southwest and reports the introduction of the Short motor on the Houston, Texas, street car lines with good prospects for its introduction at other important places in the South.

Mr. James I. Ayer, general manager of the Municipal Electric Light and Power Co., has assumed charge of the Citizens' Electric Light and Power Co., of East St. Louis. A 1,000 light alternator and a Russell engine, 14x20, have lately been added to this station.

MR. G. PANTELEONI, Western representative of the Westinghouse Electric and Manufacturing Co., has made the following sales: Moberly, Mo. 750 incandescent lights; Lagrange, Texas, 750 lights; Paris, Texas, 500 lights; Waco, Texas. 500 lights; Hot Springs, Ark., 1,500 lights; San Luis Potosi. Mexico, 1,500 lights; and the Missouri Electric Light and Power Co., St. Louis. two 400,000 watt alternators. These generators are the largest yet manufactured in this country and are being constructed on a special order.

THE EMERSON ELECTRIC MANUFACTURING CO. have removed to their new quarters, Nos. 1110 and 1112 St. Charles street, where they have ample room to provide for their large and rapidly extending business. The building has a frontage of 50 feet on St. Charles street, and a depth of 100 feet, and is three stories in height. A handsomly fitted up office is located on the ground floor.

THE ST. LOUIS AND SUBURBAN RAILROAD have discontinued the use of their narrow-guage locomotives on the central section of their road from Vandeventer avenue to Wells station, and have substituted electric cars. The cable section will be put into operation with electric power as soon as new rails can be laid and bonded.

NEW YORK NOTES.

THE GOUBERT MANUFACTURING COMPANY, 32 Cortlandt street, New York City, are doing a very large trade in their well-known "Goubert Feed-Water Heaters." They report the following among their sales for the month of October: The Edison Electric Illuminating Company of New York, one 400 h. p., one 600 h. p. and one 2,000 h. p; J. B. Ford & Co., Wyandotte, Mich., 1,000 h. p.; Hathaway Manufacturing Co., New Bedford, Mass., 1,200 h. p.; Ottumwa Railway, Electric and Steam Co., Ottumwa, Ia., 350 h. p.; The De La Vergne Refrigerating Machine Company, New York City, 2,250 h. p.; Lonsdale Company, Lonsdale, R. I., 1000 h. p.; Wamsutta Mills, New Bedford, Mass., 1,600 h. p.; Detroit Electric Light & Power Co., Detroit, Mich., 1,000 h. p., besides a number of smaller heaters.

MR. M. T. DAVIDSON the well-known steam pump builder of Brooklyn, finds business extremely good. He has recently made a sale of a large air pump and jet condenser to the Kilmer Manufacturing Company, of Newburgh, N. Y. A number of the same style pumps have also been furnished the Glengon Iron Company at Glengon, near Easton, Pa. A steady demand for Davidson pumps comes from the East, and Mr. Davidson has shipped a very great number to that part of the country of late.

THE SAFETY INSULATED WIRE AND CABLE CO., of 232 to 242 West Twenty-ninth street, have recently issued a pamphlet entitled "Underground Electric Light Cables," containing a number of testimonials from electric light companies, both at home and abroad, speaking in the highest terms of the cables made by this company.

MESSRS. H. WARD LEONARD & CO. have issued a thirty-two page pamphlet of testimonials and references regarding past work, and indicating their experience and standing.

WESTERN NOTES.

THE ST. LOUIS AND SUBURBAN RAILWAY COMPANY, formerly a combined cable and steam railroad, but which has recently been changed to an electric line, has had some remarkable experiences at its new power plant. As in all electric railway stations, the work varies enormously, sometimes changing from nothing to over 600 h. p., in less than one minute. This has caused the boilers to foam, or prime, and on two occasions, it is reported, the large Corliss engine would certainly have been wrecked had it not been for the Pond separator, which is located in the main steam pipe near the engine. Two additional Corliss engines are now being installed, and they also, will be protected by the Pond separator. This device for removing the entrained water from steam is manufactured by the Pond Engineering Company, St. Louis. They report additional orders from M. Beatty & Son, Welland, Ont.; Union Mfg. Co., Champaign, Ill., Du Pont Paper Co., Louisville, Ky.; Cicero and Proviso Railway, Chicago, Ill., two; St Louis Smelting and Refining Co., St. Louis, and John Ranning, St. Louis.

THE ILLINOIS ELECTRIC MATERIAL CO. have recently closed a large order for cedar poles and also secured a considerable order for their new taped "Canvas Jacket," which consists of a special tape next the copper and a single weave over all. This wire, it is claimed, is one of the strongest and best insulated wires in the market. Star Electrix sockets and specialties, for which this company are the general agents, are in great demand, and the Bishop rubber-covered wires and cables are general favorites. The Illinois Electric Material Co. recently received an order from Cuba for a nice bill of miscellaneous electrical supplies and are opening quite a trade with the Spanish-American countries.

THE QUAKER CITY ELECTRIC CO. report the following recent installations: An arc and incandescent plant for the Cantrell Tool Co.'s new works, Millmont, Reading, Pa.; an incandescent plant on the large Penn Valley stock farm of Mr. H. S. Henry, Morrisville, Pa.; a large incandescent plant in the wall paper factory of Messrs. Cresswell & Washburn, Phila., comprising an Ideal automatic engine; an incandescent plant in the factory of Valloth & Wadlinger, Phila., proprietors of the High Art Embroidery and Needle Work Establishment, which is an entirely new industry in this country. This plant also comprises a Williams automatic engine.

THE ENTERPRISE CONSTRUCTION AND SUPPLY CO., 167 Gravier street, New Orleans, La., the general agent for the Southern States of the Ball Electric Light Co., are installing a large number of these popular arc-light plants in mills, factories, etc. The subdivided arc lamps of 800 nominal c. p. are in special demand and giving great satisfaction. With this system also incandescent lamps are being used from the same dynamo which operates the arc lamps, with great success.

MR. J. R. BURDICK, the popular and well-known representative of the H. W. Johns Co., was in Chicago last week and called at the Western office of THE ELECTRICAL ENGINEER. Mr. Burdick is now furnishing his famous Vulcabeston insulating spools and magnets, commutator rings, etc., to almost all of the Western manufacturing companies both East and West. Mr. John Markle, of Detroit, also dropped in at the office of THE ELECTRICAL ENGINEER last week.

THE GOODRICH-COLEMAN ELECTRICAL WORKS, No. 31 S. Canal street, are very busy manufacturing their various specialties. Among other electrical devices they are manufacturing a new bell of special construction, which is giving excellent results. They have a well-equipped shop and all necessary tools for the economical manufacture of electrical apparatus of all kinds and of the very best workmanship.

MR. WM. HOOD, No. 239 La Salle street, is now furnishing the well-known "Jewel" lamps with hooked filaments for street car York and locations where the lamps are subjected to vibratory strains, and they are meeting with a ready sale. He is also placing "Jewel" lamps on the market in various colors, including red, green, blue, etc. These latter lamps are especially suitable for interior decorative work.

THE CENTRAL ELECTRIC COMPANY report that their new Gladiator dry battery is meeting with the most unexpected success; the factory supplying them is already doubling its capacity, so as to meet the increased demand for these cells. The company also report a very satisfactory trade in the Bryant goods, such as sockets, switches, cut outs, etc.

WORLD'S FAIR NOTES.—The contract for the fire alarm and police telegraph system for the World's Columbian Exposition has been let. The Gamewell Fire Alarm Co. secured the contract for the fire alarm telegraph system, and the police telegraph portion of the work was awarded to the Chicago Police Telephone and Telegraph Co.

THE NEW YORK AND OHIO CO., manufacturers of the Packard high-grade incandescent lamp, have transferred their Chicago agency to the Electrical Engineering & Supply Co., No. 931 The Rookery, and they will immediately lay in a stock of Packard lamps, so that they can fill all orders promptly from stock.

THE NEW YORK INSULATED WIRE CO., through their Western manager, Mr. Geo. H. Meeker, are securing some large orders for Grimshaw wire and cables. The new Vulca interior wire ducts are also meeting with a ready sale and attracting considerable attention.

A NEW STYLE OF DUCT.—A striking sight in the streets of Chicago is the new horse and handsome truck bearing cases of wire and the familiar trade-mark of Grimshaw white core wire and Vulca wire ducts of the New York Insulated Wire Co.

CLARK & MARSHALL, No. 500 Insurance Exchange Building, Chicago, dealers in electrical supplies, recently started in business, are working up a nice trade. They are making a specialty of fixtures and incandescent lamps.

MR. DECKER, of the Thomson-Houston Electric Co., has come from the factory at Lynn, Mass., and will be stationed with the Western office of the company.

MR. C. K. LONGENECKER, superintendent of the Weston Engine Co., of Painted Post, N. Y., was a recent visitor to Chicago.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

SUPPLEMENT TO

THE BERLINER MICROPHONE—A BROAD PATENT ISSUED TO-DAY.

During the past week the daily press has put forth a number of more or less startling announcements of an extension of the Bell Telephone patent, alleged to have been made or about to be made by the Patent Office. Probably few if any persons at all acquainted with the present patent laws were much disquieted by such reports. Such persons well knew that the strongest hold of the American Bell Telephone Company in maintaining its grasp upon the telephone service of the country through patent protection after the expiration of the Bell patent in 1893 lay in the possibility of controlling the fundamental features of the microphone transmitter. Much has been said and written touching the interference in the Patent Office between the principal rival claimants to the invention of the microphone, Berliner and Edison; both of whose claims have since the autumn of 1879 been owned by the American Bell Telephone Company. That company has been severely and bitterly criticised—apparently not wholly without reason—on account of the extraordinary delay in bringing the interference to a final adjudication. It has been obvious that the later the decision of the case, the further into the future the period of the resulting patent would extend.

The interference is now terminated and a very broad patent has been issued to Emile Berliner this day. It is entitled "Combined Telegraph and Telephone;" its number is 463,569, and it is dated November 17, 1891. Mr. Berliner's application was filed June 4, 1877—more than fourteen years ago. The drawings show a transmitter having a metal diaphragm in contact at its centre with a metallic screw, the pressure of which upon the diaphragm can be regulated; the contact end of the screw is shown in part of the drawings as carrying a metal ball or sphere; in other drawings the end of the screw is merely rounded. The specification contains the following:

My invention consists in a new and useful improvement in transmitters for electrically transmitting sound of any kind, of which the following is a specification.

It is a fact that if at a point of contact between two conductors forming part of an electric circuit and carrying an electric current the pressure between both sides of the contact becomes weakened the current passing becomes less intense—as, for instance, if an operator on a Morse instrument does not press down the key with a certain firmness the sounder at the receiving-instrument works much weaker than if the full pressure of the hand had been used. Based on this fact I have constructed a simple apparatus for transmitting sound along a line of an electric current. * * *

The said ball and plate are included in circuit with an electric battery, so that they form electrodes, the current passing from one of them to the other. By making the plate vibrate the pressure at the point of contact becomes weaker or stronger as often as vibrations occur, and the strength of the current is thereby varied accordingly.

It is not essential that the plate should be of metal. It can be of any material able to vibrate, if only at the point of contact suitable arrangement is made so that the current passes through that point. The plate may be of any shape or size, or other suitable vibratory media may be used—a wire, for example. Any other metallic point, surface, wire, etc., may be substituted for the ball. There may be more than one point of contact to be affected by the same vibrations. Both of the electrodes may vibrate, although it is preferable that only one should.

The following disclaimer is made:

I do not claim that I am the first inventor of the art of transmitting vocal and other sounds telegraphically by causing electrical undulations similar in form to the sound waves accompanying said sounds. Neither do I claim that I am the first who caused such electrical undulations by varying the resistance of an electric circuit in which a current was passing.

The claims are as below:

1. The method of producing in a circuit electrical undulations similar in form to sound waves by causing the sound waves to vary the pressure between electrodes in constant contact so as to strengthen and weaken the contact and thereby increase and diminish the resistance of the circuit, substantially as described.

2. An electric speaking telephone transmitter operated by sound waves and consisting of a plate sensitive to said sound waves, electrodes in constant contact with each other and forming part of a circuit which includes a battery or other source of electric energy and adapted to increase and decrease the resistance of the electric circuit by the variation in pressure between them caused by the vibrational movement of said sensitive plate.

3. The combination, with the diaphragm and vibratory electrode, of a rigidly held opposing electrode in constant contact with the vibratory electrode, substantially as described.

4. In a telephonic transmitter, a vibrational plate made concave for condensing the sound, substantially as set forth.

5. In a telephonic transmitter, a vibrational plate provided with one or more apertures, as and for the purposes set forth.

6. A speaking-telephone transmitter comprising a diaphragm or disc sensitive to sound waves, combined with a rigidly held but adjustable electrode in contact with the same, whereby the electric current is transformed into a series of undulations corresponding with the vibrations of said diaphragm.

On July 20, 1877, Thomas A. Edison filed in the Patent Office an application for a patent for an improvement in speaking telegraphs, in which he stated that the object of the invention "is to transmit the human voice over telegraphic wires for conversational purposes." This application was assigned to the Western Union Telegraph Company, and was one of those which were transferred to the American Bell Telephone Company under the provisions of the contract entered into when the Dowd case was settled.

The important claim in this application is one which was inserted by amendment after the case had been for some time pending in the Patent Office. It is as follows:

Third. In a telegraphic apparatus operated by sound, the combination with the diaphragm of one or more contact points of plumbago or similar inferior conductor, in the electric circuit, whereby the rise and fall of the electric tension is proportionate to the pressure exerted upon the said point or points by the diaphragm, substantially as set forth.

The specification describes a metallic diaphragm mounted at the inner end of a mouthpiece of the ordinary type, and a contact point of plumbago mounted upon a slender spring, by the resiliency of which the plumbago is lightly pressed against the centre of the metallic diaphragm. This is the Edison case that has been in interference with Berliner.

That interference is said to have been actually discontinued or disposed of some years ago, although we recall no public notice of the fact.

The claims of the Berliner patent appear to be of a very broad character, and to cover an essential element in about all the transmitters employed in telephone service. The approaching issue of the patent was doubtless known to many persons. Rumors in regard to it were probably the source of the newspaper reports of a probable extension of the "Bell patent." The price of American Bell shares five days ago was 185; to-day shares were sold at 210. Evidently persons were to be found who believed they had good reason to anticipate increased value.

The famous interference case has been a theme of much curiosity and interest now these many years; little has been publicly known of its status beyond its apparent immobility. Commissioner Simonds decided against Drawbaugh, who was a party, a few weeks ago. That decision is said to have cleared the way for the allowance and issue of the Berliner patent of this day.

It is too early to undertake any critical examination of the patent or to express an opinion as to its scope. Should it be found broad enough to control the use of all practicable microphones, it is considered doubtful, in view of the circumstances of the long delay in its issue, whether the United States Courts would sustain it to the extent of permitting its owners to enjoy its protection for the next seventeen years.

THE

Electrical Engineer.

VOL. XII. NOVEMBER 25, 1891. No. 186.

MULTIPOLAR DYNAMOS AT THE FRANKFORT EXHIBITION.—I.

BY

E. Kolben.

ALTHOUGH the multipolar machine has always been exclusively used for alternating-current generators, this type has not until recently found more general application for continuous currents, chiefly on account of the mechanical difficulty of building up large commutators with a great number of divisions, a necessary adjunct to multipolar continuous-current machines. The expense, however, incurred in the labor and material for these large commutators is small as compared with the saving that can be effected in iron and copper, by making all machines of considerable output multipolar in preference to bipolar, even though the bipolar type may be run at very high speeds. The Edison 200 K. W. dynamo, which has found so much favor in this country as a railway generator, is probably the largest bipolar dynamo ever built. Although its electrical and commercial efficiency is the highest obtainable, it is heavy for its output, and its weight would be looked upon with astonishment by German electricians. Most of the machines exhibited at Frankfort were multipolar, and this is the reason why Mr. Ravenshaw, in the London *Electrician*, notices particularly that their commutators are so "immense." There were exhibited two distinct types of multipolar machines, the designs of which differ very considerably from one another. The largest type is the "slow speed" for central station work and the smaller is the high speed, belt-driven type. It will be convenient to notice these under the respective headings, "Central Station Dynamos," and "Belt Driven Dynamos."

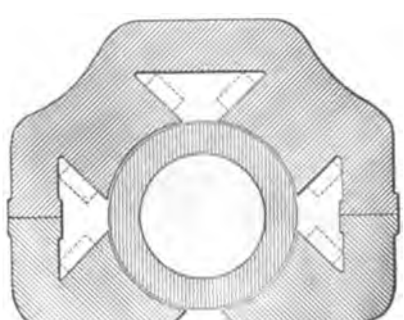


FIG. 1.—TYPE NO. 1. IRONCLAD TYPE OERLIKON DYNAMO.

CENTRAL STATION DYNAMOS.

These are exclusively direct-driven slow-speed machines. Of the various types of field magnet frames that have been employed in practice, the following three patterns only have proved to be the most efficient and have been exclusively adopted by the largest firms.

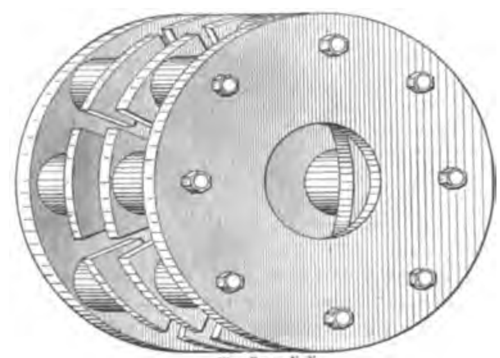


FIG. 2.—TYPE NO. 2. DIRECT FIELD TYPE.

Type No. 1. *Iron Clad Type, Fig.* 1.—These are built by the Allgemeine Elektricitäts-Gesellschaft, Berlin; Oerlikon Machine Works, Oerlikon, Switzerland; Société Gramme, Paris; Lahmeyer & Company, Aachen, Germany; Gisbert Kapp, London.

Type No. 2, *or Direct Field Type, Fig.* 2.—These are built by Schuckert & Co., Nuremberg, Germany; Fritsche & Pischon, Berlin.

Type No. 3, *or Innerpole Type, Fig.* 3.—These are built by Siemens & Halske, Berlin and Vienna; C. F. Fein, Stuttgart, Germany; Ganz & Co., Budapest; Compagnie de Construction Alsacienne, Belfort, France.

The field, Type No. 1, seems to meet with the most general favor. It is very economical, cheap to manufacture, permits of the armature being supported centrally, and does not limit the number of poles. As to the weight, a comparative calculation will readily show that it stands between Type No. 3, which is the lightest, and Type No. 2, which is the heaviest, on account of the magnetic circuit being split into two parallel halves. A field of Type No. 2 can only be used to advantage with flat ring and wheel armatures.

A field of No. 3, or the innerpole type, necessitates the construction of an overhanging armature. This construction is good enough for small sizes, but does not seem safe for large central station machines. It also limits the number of poles, a serious disadvantage for large size machines running at a very slow speed. In this type the advantage of the materially reduced length of magnetic circuit is much counter-balanced by the reduction in the number of poles, and the machine becomes almost as heavy as Type No. 2. The small number of poles also makes it necessary to design the machine with heavy armature effect; this makes the machine very sensitive to changes of load, and consequently increases the liability to sparking. Another disadvantage of this type is that the limiting circumferential speed is not the effective speed on the internal circumference, but this ineffective external speed is the wound with copper bars which form a commutator on the external circumference. The writer has seen its construction as well as its operation in the large central stations of Berlin and Vienna, and also the running of several of the

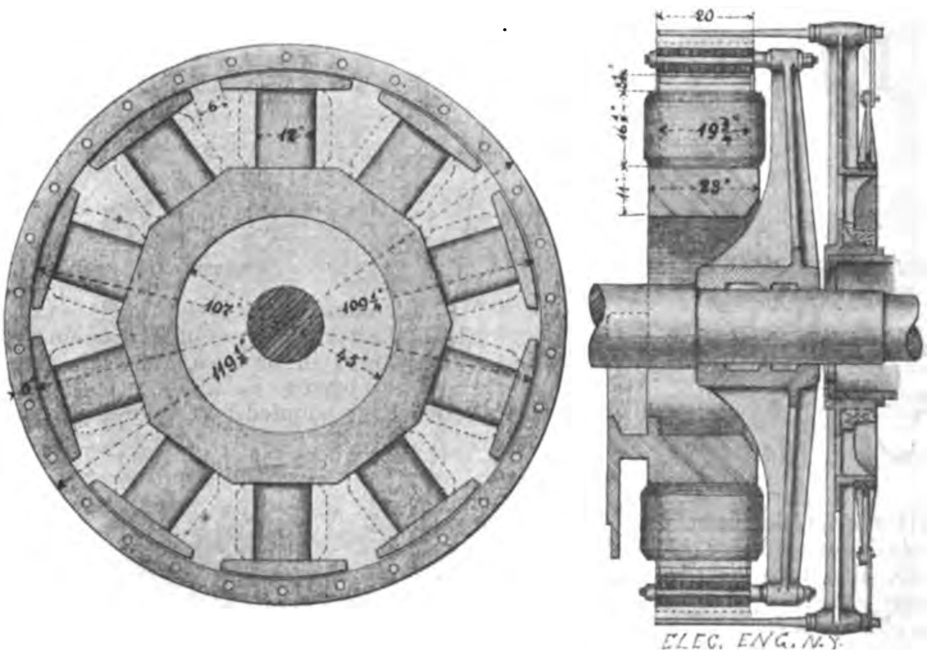


FIG. 3.—TYPE NO. 3. INNERPOLE TYPE. 10 POLAR, 330 KILOWATT, SIEMENS & HALSKE DYNAMO.

mechanical speed limit, and also the brush-friction speed limit. As a consequence of the fact that the circumferential speed is not the effective speed, these machines must run at a slower speed than those with field No. 1. This condition is still more disadvantageous with machines of Type large sizes at the Frankfort Exhibition. The largest size now manufactured has an output of 330 kilowatts. This runs at a normal speed of 65 revolutions per minute.

The armature bars are thin and high, and they are cotton covered. There are large open spaces between bar and

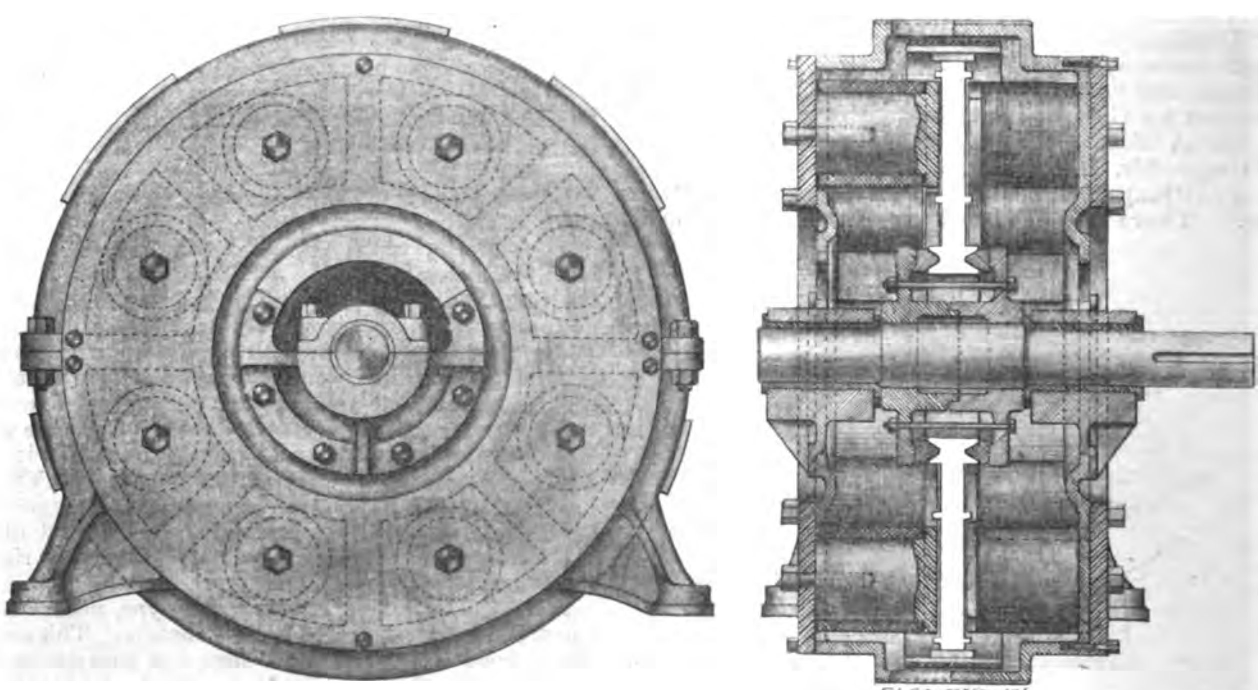


FIG. 4.—END ELEVATION AND SECTION OF FRITSCHE-PISCHON DYNAMO.

No. 2, where the internal circumferential speed is very much reduced, thus increasing the size of the machine required for a given output.

The innerpole machine is chiefly built by Siemens & Halske as a central station machine, having armatures bar. The body is assembled from sectional sheet-iron discs. The following data may be of interest :

Output, 140 volts, 2,360 amperes, at a speed of 69 revolutions per minute.

Internal diameter of armature body....109¼ inches.

External diameter of armature body	119¼ inches.
Length of body	20 "
Total number of bars on circumference	810
Number of poles	10
Cross-section of wrought-iron cores, 12 x 19¾ inches.	
Neutral space between pole-pieces	6 "
Height of armature bar	⅞ "
Thickness of armature bar	$\frac{1}{16}$ "

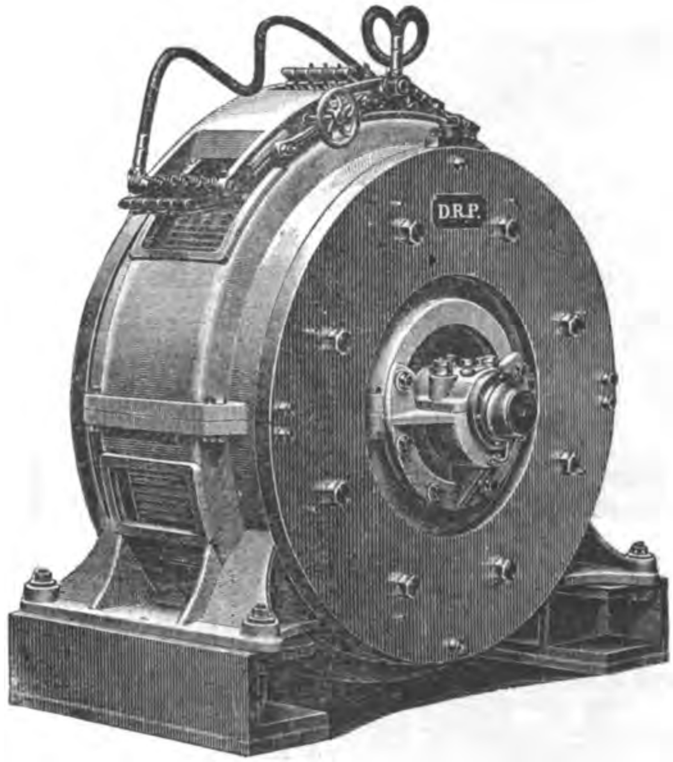


FIG. 4A.—FRITSCHE-PISCHON DYNAMO.

Armature resistance	.00164 ohms.
Field magnet resistance	2.8 ohms.
C^2r loss in armature at full output	9,130 watts.
Hysteresis loss at an induction of 12,500 lines per square centimetre	3,130 watts.

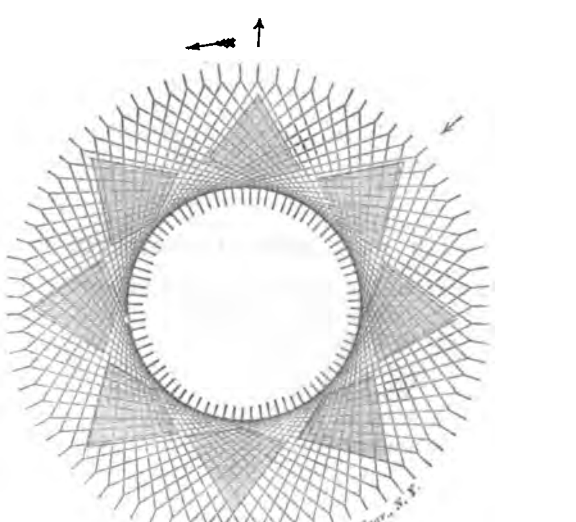


FIG. 5.—DIAGRAM OF FRITSCHE-ROSE WINDING (WELLEN-WICKLUNG) FOR WHEEL ARMATURE.

From these figures it would appear that the machine has not quite the efficiency that might be expected of a central station machine of this size.

Type No. 2, or Direct Field Type.—This has been adopted by Fritsche & Pischon and by Schuckert & Co. The Fritsche wheel dynamo was probably the most original continuous-current machine in the exhibition, and although the machine in its present form is expensive to build, both in respect to magnet frame and armature, a detailed description of its construction will be of interest to American readers.

The magnet frame proper is built up entirely of wrought iron, and is enclosed in a cast iron shell, which protects the

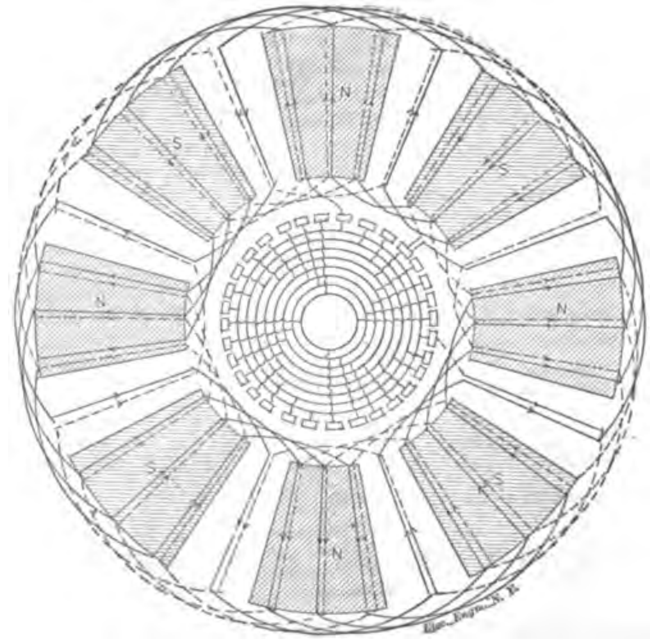


FIG. 6—DIAGRAM OF SERIES CONNECTIONS FOR FLAT RING OR WHEEL ARMATURE.

whole machine, Fig. 4. The wheel armature is a fine piece of elaborate European workmanship. The armature was originally provided with the well-known Fritsche "rose winding," Fig. 5, described in the German Patent No. 45,808, but this method, on account of manufacturing difficulties, has now been abandoned. A single layer of straight radial strips is employed, together with a series of cross-connection (similar to H. Mueller's method, U. S. patent No. 331, 762), using insulated copper strips, partly

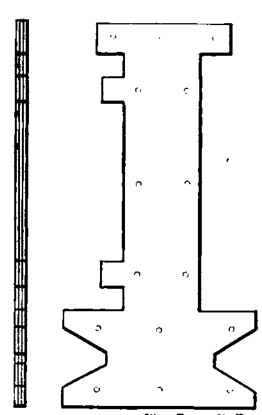


FIG. 7.—ARMATURE BAR OF FRITSCHE WHEEL DYNAMO.

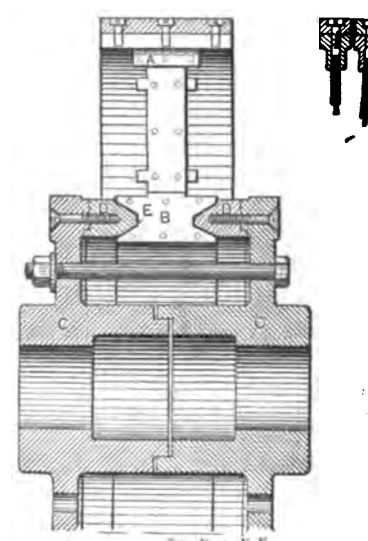


FIG. 8.—SECTION OF ARMATURE OF FRITSCHE DYNAMO.

upon the external and partly upon the internal circumference of the armature, as shown in Fig. 6.

The armature bars consist of specially shaped punchings of sheet iron and sheet copper, which are riveted together. They are long and thin, and are illustrated in Figs. 7 and 8. The punchings are soldered and riveted at the top and bottom to the specially shaped brass castings A and B. Copper bars are screwed on to the castings A, which are then turned off on the circumference and serve as commutator blocks. As the armature loops are connected in series, two sets of brushes only are required. The lower castings B are mortised on both sides, and by this means the whole armature is clamped together with strong cast iron hubs, C, which have brass end rings, D, in order to magnetically insulate the hub from the armature bars. Pressed board insulation, E, is used between the ring D and the armature spokes. The largest machine that is being built at present is designed for 180 K. W., and the following data regarding it will be interesting;

Output	150 volts 1,200 amps.
Speed	100 revs. per minute.
Weight of armature	8,800 lbs.
Weight of copper on fields	1,080 lbs.
Total weight of machine complete	20,240 lbs.
Loss in magnet and armature conductors	3.5 per cent.

The following is a table of sizes and general data of the standard Fritsche machines:

	Output in Kilowatts.	Volts.	Amps.	Speed.	Number of poles.	Weight complete in lbs.
Exhibition Machine	32	160	200	400	4	5,280
	48	160	300	140	8	8,800
	180	150	1,200	100	12	20,240

Fig. 4A shows the machine in perspective.

THE CENTRAL STATION AT BARRANQUILLA, U. S. C.

THERE has lately been a marked increase in the number of electric light stations in the West Indies, Central America, etc., and a notable feature of this work has been the fact that American apparatus is used almost entirely. We have recently illustrated and described the central stations at Kingston, Jamaica, equipped with a Thomson-Houston plant, and at Havana, Cuba, equipped with a Westinghouse outfit; and we now have the pleasure of showing the station at Barranquilla, United States of Colombia, where a Fort Wayne plant has been installed. It is interesting to learn that this plant has already proved

FIG. 1.—FORT WAYNE STATION, BARRANQUILLA, U. S. C.

inadequate for the needs of a city of 30,000 inhabitants, and that it is to be largely increased. Moreover, the lighting for the neighboring city of Cartagena is now under negotiation, with every prospect of an early settlement of the matter.

The station at Barranquilla, shown in Figs. 1 and 2, consists of a Fort Wayne alternating dynamo, of 650 lights, of 16 c. p., separately excited. The dynamo is driven by a 12x12 Ball engine, to which steam is supplied by a boiler of 80 h. p. constructed by the Erie City Iron Works. For street lighting seventy 25 c. p. lamps are used in ten circuits, each circuit being run in series. On the "commercial" circuits five hundred 16 c. p. lamps have been wired up and are now in use for lighting stores, residences, etc.

FIG. 2.—FORT WAYNE STATION, BARRANQUILLA, U. S. C.

The work of installing the electrical plant was under the direction of Mr. W. H. Coles, of this city, who was engaged by the company to undertake the task; and the results have proved very satisfactory. The officers of the Empresa del Alumbrado Electrico de Cartagena y Barranquilla are Ed. Meyer, president; J. M. Larralde, secretary and treasurer; and J. M. Lamadrid, superintendent. The company's New York offices are at 18 Broadway.

In spite of political troubles and financial disquietude, electrical progress in South America during the past year has been very striking and encouraging. Central stations and isolated plants, electric roads, and electrical power plants for mining have been in demand, and have been installed all over that continent; and it is gratifying, to say the least, to state that two-thirds of the material has been furnished from the United States. We are indebted to Mr. W. H. Fleming, E. E., of this city, for the photographs and data of the above plant, that gentleman giving his attention specially to electrical engineering work in the Spanish-American field.

A NEW KENNEDY ALTERNATOR.[1]

THE alternator we illustrate herewith has been constructed by Mr. Rankin Kennedy, of Glasgow, and belongs to that class in which both the exciting and the generating coils are fixed, the revolving part consisting of laminated iron inductors. Machines of this class have been made by many inventors, such as R. Knight, Wheatstone, Henley, and lately by Kingdon on a large scale. Such dynamos have also been designed by Mordey and Forbes.

The points of novelty in this new machine are chiefly the arrangement of the coils of wire and the construction of the magnetic circuits, whereby only two exciting coils and two generating coils are required, however large it may be made, and however great may be the pressure and frequency of the alternating current required. The machine very much resembles a transformer in its parts, and is about as simple in construction. The iron field magnet portions surround the copper coils, which are simple rings

1. *Industries.*

of insulated wires; the inductors are carried on gun-metal wheels, and in revolving alternately open and close the magnetic circuit round the copper coils, thus inducing current in them. There is no reversal of magnetism in any part of the operation of the machine, only a simple rising and falling of the magnetic flow without reversal. The iron is made of very ample sections, so that the induction is never high, and never falls to zero. The excitation is constant, but the induction varies with the position of the inductors. In a machine recently built, and which is illustrated in Figs. 1, 2, 3 and 4, the E. M. F. was 8 volts per turn of generating coil, the speed 750, the excitation 15 amperes under 35 volts, the inductors were 6 on each side; the total pressure was 2,400 volts; with 300 turns of wire on generating coil the output was 24,000 watts. Fig. 3 is a general view of the machine. Fig. 1 is a view of the inductors on the shaft. Fig. 2 is a view of one pair of coils, and Fig. 4 shows the construction of one of the field magnet blocks.

There are two pairs of coils in the machine, and two sets of inductors placed as shown in Fig. 1. The generating coil is wound first and insulated, then the exciting coil is wound over that, and the whole is insulated and fixed in the machine in the recesses formed in the field blocks, as shown in Fig. 4. By using two pairs of coils and two sets of inductors, and exciting the coils so that the field blocks are magnetized with a pole in the middle and similar poles at each end, as marked in Fig. 4, when the two exciting coils are in "series" with each other, any inductive effects on the one exciting coil are exactly and entirely neutralized by those effects on the other exciting coil. The two generating coils can be coupled either in series or in parallel, but the exciting coils must always be in series. This machine is exceedingly simple and inexpensive to build, and there is no difficulty with insulation or in constructing them for any pressure or frequency required. In large dynamos there are four pairs of coils and four sets of inductors. In the machine illustrated the inductors are 21 inches diameter, the coils being 21¼ inches inside diameter; the electromotive force of the generating coil is about 1.35 volts per foot working at very moderate inductions and at moderate speed, and this can be safely raised to 2 volts per foot. For low-pressure alternating currents this machine is equally applicable.

In central stations for electric lighting supply in districts where the stations are surrounded by consumers it is advisable to use low-pressure dynamos, so as to supply the immediately surrounding neighborhood direct from the dynamos, and to supply the distant consumers through step-up transformers. As a motor this machine works well, but has to be brought up to synchronism, like all other synchronizing alternators.

A machine with inductors 4 feet in diameter gives an output of 150,000 watts (100 volts 1,500 amperes) at a speed a little over 200 revolutions per minute. This is suitable for low-pressure distribution near the station, and high-pressure at a distance by means of step-up transformers.

In Fig. 2 P^1 P are terminals of the exciting coil, S^1 S are the terminals of the generating coils. By using only two coils in large slow-speed machines it is expected that the complications hitherto met with in large machines are obviated, most of them requiring two generating coils for each period per revolution. An ordinary machine making one revolution per second would require 200 coils to give a frequency of 100 per second. The machines are specially designed for continuous running at central generating stations.

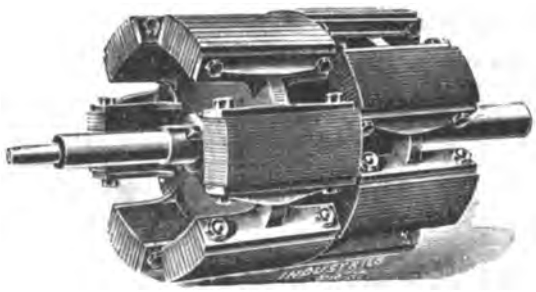


Fig. 1.—General View of Inductors.

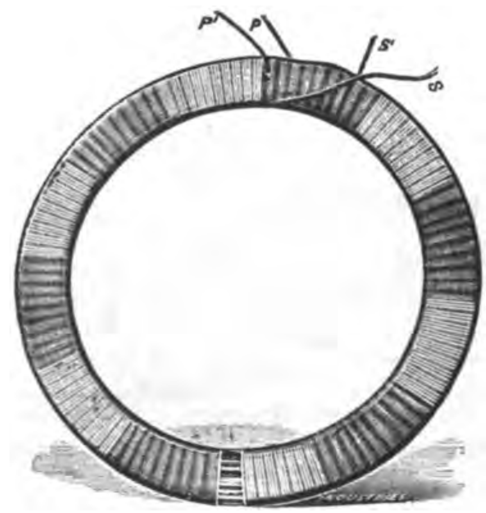


Fig. 2.—Pair of Coils.

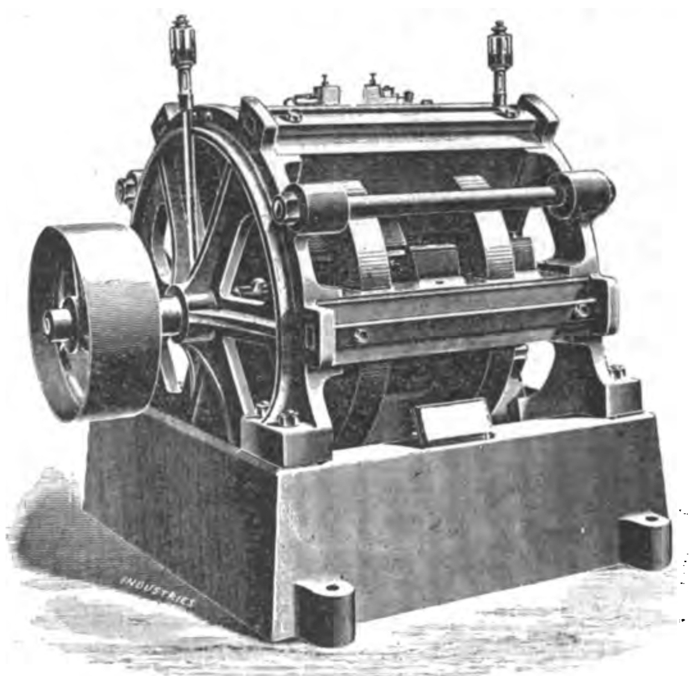


Fig. 3.—The Alternator Complete.

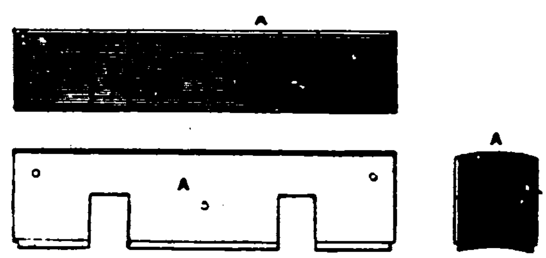
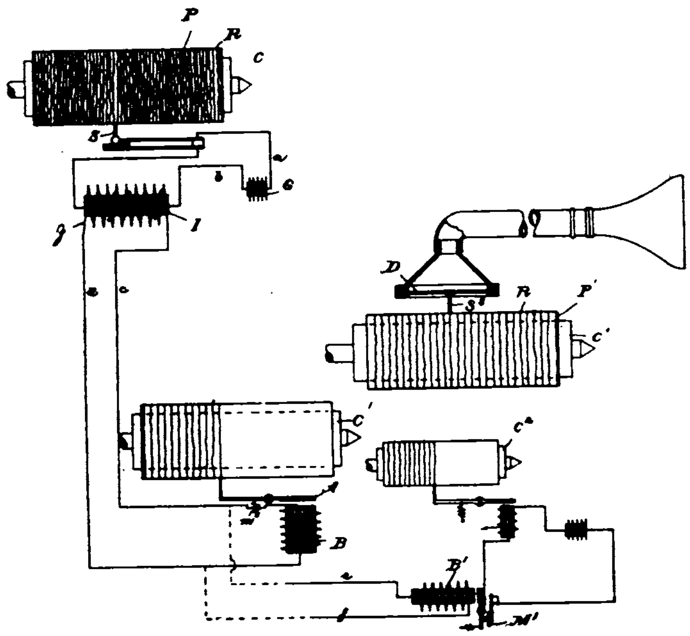


Fig. 4.—Field Magnet Block.

The New Kennedy Alternator.

THE GIBBONEY LONG-DISTANCE TELEPHONE.

In order to increase the distance through which the articulations of the human voice may be electrically transmitted, Mr. John W. Gibboney, of Lynn, Mass., has devised a system which consists in making a phonographic record of the sound waves, and causing this record to produce corresponding undulations at a reduced pitch and transmitting them over the line, where they are again recorded at the receiving end of the circuit.



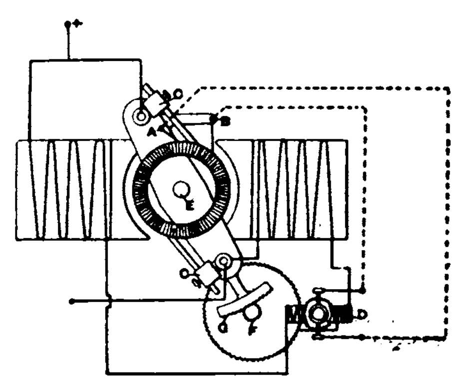
The Gibboney Long-Distance Telephone System.

The accompanying illustrations clearly show the operation of the system. Here Fig. 1 shows the application of the record to the production of electric impulses, Fig. 2 shows the sound reproduction through the agency of an electric wave record, and Fig. 3 is an illustration of the method of recording at the receiving end of the circuit. After the record is first made the stylus is substituted for the follower s, Fig. 1, which controls a variable resistance transmitter in an electric circuit *a b*, this circuit passing around an induction-coil I. If now the cylinder P be rotated at the same rate as when the record was made, electric undulations will pass over the line *c d* to the further end of the circuit; but if this circuit be of considerable length, or have a large amount of self-induction or impedance and the electric waves are rather quick in character, it is well known that their transmission becomes difficult and even impossible, because they are smoothed out, obliterated, or distorted in such manner that they cannot be recognized as representing faithfully the original impulse. This difficulty is obviated by rotating the cylinder C at a reduced rate from that at which the record was made, whereby the electric undulations of current, while having a character corresponding to the sound waves, are prolonged in period. These waves may be passed over the circuit *c d*, and because of their slowness may be transmitted with greater fidelity than would be the case were they made to correspond in period with the pitch of the sound wave. At the receiving end of the circuit these waves are passed through a magnet B, whose armature operates or controls the movements of a stylus, reproducing upon a phonogram-blank upon the cylinder C′ a record corresponding to the electric waves transmitted over the line *c d*. If now the stylus s, Fig. 1, be replaced by the follower s², Fig. 2, and the cylinder C² revolved at the same rate as when the electric-wave record was put upon it, the sound produced would correspond in pitch to the pitch or period of the electric waves which produced the record; but if its speed of rotation be increased sufficiently, the sounds emitted may be made to coincide in pitch with the original sound used in making the initial record at the sending-station.

When desirable to relay the current at the receiving end of the line, the slowness of the period of the waves renders this an easier matter than ordinarily. Thus in Fig. 3 the current between the lines *c d* passes through a magnet B′, operating a variable circuit-controller M′, controlling a local circuit, and passes about a magnet B², which operates a stylus bearing upon a phonogram-blank, upon the cylinder C². The record R² will correspond in character to that upon the original cylinder.

A NEW DYNAMO BRUSH REGULATOR.

A novel system of regulation for dynamo brushes has recently been devised and patented abroad by Messrs. H. Cuénod, E. Sautter and G. Hochreutiner, of Geneva, Switzerland. By this invention a precise adjustment of the brushes to the line of commutation is obtained, and it consists of the combination with one of the collecting brushes of the dynamo of two tell-tale brushes, placed the one in front, the other in the rear of the collecting brush, and with such an arrangement that a difference of potential existing between the two tell-tale brushes may produce the necessary displacement of the collecting brushes so that they may be turned into their proper position. Several methods of carrying this into effect are described, one of which is shown in the accompanying illustration. Here A B are the two tell-tale brushes placed the one in front and the other behind one of the principal brushes C which require to be regulated. The brushes A B are connected to the armature of a small motor, D, separately excited. This motor D governs the brush carrier E by means of a train of gearing F and a toothed segment, G, and the brush carrier E can be turned in one or the other direction around the axis of the dynamo according as the current traverses the armature in one direction or the other. The tell-tale brushes are adjusted in such a manner that in the mean position the principal brush is exactly adjusted upon the line of commutation, and there is no difference of tension between A and B. When any displacement of the principal brush takes place a current will be immediately sent in one direction or the other through the motor.



Dynamo Regulation with Auxiliary Brushes.

A NEW ELECTRICAL MACHINE.

At a recent lecture M. Henri Becquerel exhibited an ingenious frictional electrical machine, devised by his demonstrator, M. Peignot. Mercury is forced by means of a pump through the pores of a piece of chamois leather, and electricity in considerable quantities is generated by the friction. Ducretet, the well-known Paris instrument maker, has just finished a machine of this kind for the Conservatoire. The column of mercury is 1 metre high and 30 centimetres in diameter.

ECONOMY IN ELECTRIC POWER DISTRIBUTION. LEONARD'S FACTORS "1000" AND "7.5."

BY

J. Stanford Brown.

It has been shown (Electrical Engineer, XII, No. 179, page 397, 7 O., '91) that Mr. Leonard's formula

$$(1) \qquad M = \frac{K.\ W. \times D \times 21{,}400}{V(E - V)},$$

(Electrical Engineer, XII, No. 174, page 249, 2 S., '91) can in the lettering of Mr. Sprague be written

$$M = \frac{(2\ l)\ (10.5)\ (K.\ W. \times 1{,}000)}{E\ V},$$

where the latter writes

$$M = \frac{(2\ l)\ (10.5)\ (n \times 746)}{E\ V\ a}.$$

K. W. has been defined as "Kilowatts at terminals of translating device" . . "Electric energy at the end of the conductor, *i. e.*, at the brushes of the motor," while n is the number of horse-power (watts) to be delivered by the motor on its shaft.

The first question then is, What determines the amount of energy to be delivered at the end of the conductor? For the whole problem is to proportion our conductor so that we can deliver *some amount of energy* at the far end with due regard to least first cost consistent with maximum economy of future operation.

What are the commercial conditions? We have, say, a piece of machinery to operate, requiring 2 h. p. to run it. We propose to use a motor to run that machine, and we will, for simplicity, couple them shaft to shaft. Now the amount of power at the motor terminals must be such as will enable us to get 2 h. p. out of the motor or we are not accomplishing our purpose. Furthermore, there has never yet been built a motor which would give out all the energy delivered to it, so that it is impossible in any commercial problem (problems with which engineers have to deal) to omit the motor efficiency, for if we do, as shown in above, we fail to solve the problem.

The factor "1,000" has misled several readers. One engineer suggested to the writer that the figuring had been in *K. W.*'s per 1,000 feet of transmission; but such is not the case. The expressions "*K. W.* × 1,000" and "n × 746" both represent watts. The only difference is in the number of watts contained in the unit of power selected. In the one case it is 746 and in the other 1,000, and in the latter some seem to have been somewhat confused because the unit kilowatt contained the name watt. The latter is, however, really the simplest, for it is on the metric system, and Mr. Leonard starts in the right direction when he adopts the metric system. And besides, it has been proposed to adopt 1,000 instead of 746 as the number of watts to be called an electric horse-power.

It is rather curious to note that in the case in hand the quantity (*K. W.* × 1,000) is expressed in the inverse to the usual way, that is, our unit is expressed by a number while its "numeric" is represented algebraically by n in the one case and by *K. W.* in the other. We usually have the "numeric" given in figures and perhaps this fact aided a misunderstanding at first glance.

In short (*K. W.* × 1,000) *is not the same as* "1,000 *K. W.*"

Instead of using n or m or x or any other *single letter* to denote the number (the numerical factor) of *K. W.*'s, the author of the paper under discussion preferred to make use of the double letter designation *K. W.*, which, most unfortunately for clearness, were at the same time *the initials of his unit*. That is, as used by him "*K. W.*" is the number of "*K. W.*'s." to be transmitted.

With his reply to the query in Electrical Engineer, XII, No. 182, page 472, 28 O., '91, will the author of the original paper kindly show how the factor "7.5" is obtained in the denominator of equation

$$(2) \qquad T = \frac{D^2 \times K.\ W.}{V(E - V) \times 7.5}.$$

For if 1 mil 1 ft. of cu. = .000,003,027 lb.; therefore,

$$1 \text{ lb. cu.} = \frac{1 \text{ mil } 1 \text{ foot}}{.000{,}003{,}027}, \text{ and} \qquad ``$$

if T lbs. correspond to M mils and D feet, "

$$T = \frac{M\ D}{.000{,}003{,}027}; \text{ or}$$

substituting for M its value as given in (1)

$$T = \frac{\left(\dfrac{K.\ W. \times D \times 21{,}400}{V(E - V)}\right) D}{.000{,}003{,}027}; \qquad \text{or}$$

$$T = \frac{K.\ W. \times D \times 21{,}400\ D}{V(E - V)\ (.000{,}003{,}027)}; \qquad \text{or}$$

$$T = \frac{K.\ W. \times D^2}{V(E - V)} \times \frac{21{,}400}{.000{,}003{,}027}; \qquad \text{or}$$

$$T = \frac{K.\ W. \times D^2}{V(E - V)} \times \frac{1}{\left(\dfrac{.000{,}003{,}027}{21{,}400}\right)}$$

which apparently will not give

$$T = \frac{D^2 \times K.\ W.}{V(E - V)\ (7.5)}.$$

ISOLATED ELECTRIC PLANTS FOR RESIDENCES.

BY

Francis L. Woodward.

Being much interested in an article which appeared in a recent issue of The Electrical Engineer on small electric plants for residences, by Mr. W. C. Dodge, I herewith briefly state the result of my various practical investigations upon the subject.

First, in regard to the gas engine. On a large scale, as for lighting theatres, manufactories, etc., I find in regard to the economy of electric lighting, as compared with gas lighting, that, I might say, the poorest and least economical plant for electric lighting, at present on our market, can be successfully, that is economically, operated by means of a gas engine, and will produce a much greater amount of light than could be obtained from an equal amount of gas if consumed by burners for illumination; but for residences using about fifteen 16 c. p. lamps I hardly think the gas engine a saving, in any way; at least, at the present time.

But this will not be a hindrance to the installation of small electric plants, for by the use of an automatic engine, using petroleum for fuel, which is comparatively much cheaper than gas, a satisfactory result can be obtained. There are three important points which should be regarded in selecting the engine. The principal and most necessary of these is that it should be automatic, so that practically the only attention required is that in starting and stopping the engine. The second is uniformity of speed, and the third a steady pressure. I will not discuss the requirements of the engine, however, but rather the cost of successfully operating a plant.

A first-class plant, complete, including dynamo, engine, belting, wiring, cost of installation, etc., on a basis of furnishing fifteen 16 c. p. lamps with the necessary current, can be placed at a cost not to exceed $325, and operated at a cost of about three cents an hour. To furnish the same amount of light by gas burners, consuming five cubic feet per hour, at $1.50 per 1,000, the cost would be about 11¼ cents per hour; or in one year the cost of furnishing this amount of light on an average of three hours a day is.. $394.20

With a dynamo, operated by a petroleum engine..............................	$98.55	
Incidentals to electric plants..............	25.00	
Total cost of maintaining electric plant one year..............................		123.55
Net saving in favor of plant operated by petroleum engine....................		$270.65

In many cities the cost of gas is higher than $1.50 per 1,000, in such cases the saving, by the use of electricity, would be greatly increased.

THE HUM OF MOTORS.

BY

THE hum or musical note given out by motors when working under heavy loads being a matter of interest, as having a practical bearing upon the subject of "motor design," I undertook some experiments with a view to learning more of the location and cause of this hum. The hum often being so pronounced—as in street railway motor of some types—it has undoubtedly attracted attention generally and led to no little experimenting as to its cause and cure; and it is with a hope of drawing out the result of some of these experiments that I report this one.

The motor selected for the experiment was an eight-pole machine, wrought-iron field cores and pole-pieces, with a Gramme ring toothed armature. The brushes were removed and the armature shaft so belted up that it could be driven at varying speed; while the fields were connected with a dynamo—a resistance box being placed in circuit so that the current in the fields could be varied at will. When the fields had no current flowing through them and the armature was revolved at any reasonable speed there was no sound given out, but so soon as a strong current was sent through the fields a musical hum was heard, the note increasing in force with the increase in current through the fields and increasing in height of pitch with the increase in speed of the armature. This was tried repeatedly with the same result. The armature was then replaced by a bare armature core and this was put through a similar test, with the same result.

The hum varying in pitch with the variation in speed of the armature suggested the idea of getting the pitch of the note given out for any definite speed of the armature, and hence the number of vibrations per second of the vibrating part for any definite speed of the armature, and by comparison get some idea as to the cause or location of the musical note. Not having convenient anything of known pitch, I hit upon the plan of observing at a time when the note given out was just beginning to be audible to the human ear, and hence at a time when the vibrations producing this note must be about 16 per second. From a number of observations it was found that when the note given out was barely audible the speed of the armature was about 120 revolutions per minute—2 revolutions per second. So when the part producing the hum was vibrating at the rate of 16 vibrations per second the armature was making a speed of 2 revolutions per second. Now since the motor had 8 poles, at the time of observation any point in the armature was passing from one field pole to the next 16 times per second (8x2); and since the number of vibrations per second causing the hum corresponds exactly with the number per second of changes in polarization of the armature as it passes from one field pole to the next, it is but natural to conclude that the change in polarization of the armature as it passes from one field pole to the next is the cause of the musical note so often given out by motors.

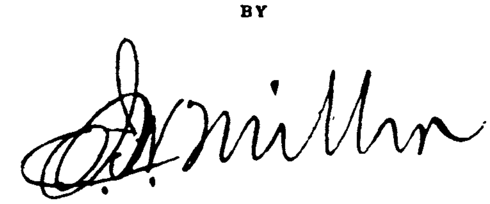
This would most probably account for the fact that this hum is most frequently met with in "multipolar" machines.

This annoyance has been often lessened by modifying the design of the machine, such as the reshaping of pole-pieces, and this experiment would seem to indicate the line along which the same thing might be accomplished to a degree without change of general design. The fact that the force of the musical note increased with increase in the current through the fields would seem to show that the note increased in force with increase in saturation in the magnetic circuit taken as a whole—field core, pole, air space and armature—and that a reduction in the possible saturation through the magnetic circuit as a whole would decrease the force of the note, but it is not so clear that a reduction in the saturation through the armature core alone—the rest of the magnetic circuit remaining the same—would accomplish the same result, although I am inclined to think that it would to a certain degree.

The experiment seeming to indicate that the musical note takes its pitch from the speed of the armature and that the note in vibrations per second corresponds to the number of times per second that the armature passes from one field-pole to the next would lead to the conclusion that in machines with armatures changing pole less than sixteen times per second there would not be given out any musical hum; but should the other necessary conditions for the hum be present to a marked degree there might be a succession of sounds. I very much hope that others will discuss this matter.

A RELIABLE CIRCUIT PROTECTOR.

BY



IN THE ELECTRICAL ENGINEER of August 26th appears an editorial upon the subject of fusible cut-outs. The conclusion reached was that neither fuses nor electromagnetic cut-outs were entirely satisfactory, and that the problem of protection against undue heating caused by excessive currents was unsolved.

Having devoted considerable time to the consideration of this subject, I would like to offer a few suggestions that may lead to better results than have yet been attained. My experiments have been made with a view of securing a reliable protector for use on telegraph and telephone lines and the results have been highly satisfactory.

It is well known that a current of one-half an ampere will set an ordinary telegraph instrument or telephone on fire if allowed to pass through it for a sufficient length of time. A protector to be effective should therefore protect against currents of one-half an ampere and upward. Fuses that will burn out with one-half an ampere of current will be destroyed by wholesale during lightning storms and render the wires practically unserviceable. As the fuses cannot be protected by lightning-arresters, their general use on all classes of lines is impracticable. The same objections hold good with the electromagnetic devices; they operate freely during lightning storms and require constant attention in order to prevent the circuits from being left open. After satisfying myself that favorable results could not be attained with either device referred to, I turned my attention to the combination of a heat coil and fuse; the former to protect against currents of from one-half an ampere to five or six amperes and the latter for all in excess of six.

The heat coil is made by winding around a lead core $\frac{1}{4}$ inch in diameter and $2\frac{1}{2}$ inches long, number 25 gauge insulated German silver wire to a resistance of 25 ohms. A lever $4\frac{1}{4}$ inches long is trunnioned at $\frac{1}{4}$ inch from one end and through this short end passes an adjustable screw which rests against the upper end of the lead core. The long end of the lever has a hook which engages a second lever. The operation of the instrument is as follows:

Whenever a current of one-half ampere or over passes through the heat coil, the lead core is heated and the expansion raises the short end of the lever and causes the disengagement of the long end, thus opening the circuit permanently. One end of the lever being sixteen times as long as the other, the expansion of the core is multiplied by 16 at the long end. A current of one-half ampere opens the circuit in 50 seconds, and as the current increases the time of opening decreases. A current of five amperes opens the circuit in two or three seconds, which is before any damage would result to telegraph or telephone instruments. Ordinary lightning discharges do not generate enough heat to open the circuit, and the instrument does not operate unless a dangerous current is introduced for two or three seconds of time. As currents over five or six amperes might cause excessive heat in two or three seconds, a fuse which will burn out with six amperes of current is placed in circuit; but its conductivity is too great to be easily burned out by lightning. This form of protector, while it protects against all dangerous currents, does not unnecessarily open the circuit. For intermediate offices, it can be arranged to cut the instruments out of circuit and at the same time leave the circuit closed throughout. At terminal offices it is arranged to leave the circuit open.

Nearly all of the largest telegraph offices in the United States and many of the telephone exchanges have been destroyed by fire within the last five years, and in almost every instance the cause has been traced to excessive currents being led into them which the wires had not sufficient conductivity to carry safely.

A reliable protector is certainly needed, and I believe it will be found in the combination of a heat coil and high conductivity fuse.

HOW BERLINER INVENTED THE MICROPHONE.

In view of the decision of the U. S. Patent Office, awarding Mr. Emile Berliner a patent on the microphone, as noted in our special Bulletin last week, the following account of the manner in which he made his discovery and invention will be of great interest. It is taken from the biographical notes prepared by him at the request of the editors of The Electrical Engineer, and upon which an illustrated biographical sketch was based, appearing November 19, 1890:

"As soon as I had returned to Washington, in 1876, I began electrical experiments, and for the purpose of learning something, paid visits to the Fire Alarm Office, where the operators were kind and ready to answer all questions.

"I had just commenced making diaphragms and contacts, and had looked up Bell's patent of 1876, when one day Mr. Richards, one of the operators, at my request, showed me how to manipulate a telegraph key. 'You have to press down harder, otherwise it may happen that the sounder at the other end will not respond well.'

"I immediately asked him for a thorough explanation of this, because it had flashed through my mind that if pressure made a difference in an electrical contact, and modified the current passing the contact, then a vibratory contact would transmit speech by means of undulatory currents. In this manner the telephone transmitter, afterwards known as the microphone, was invented.

"I at once set to work to study this principle and tried to transmit speech, using for a receiver an apparatus as shown in Bell's patent of 1876. For a transmitter I used metallic diaphragms touching screws tipped either with platinum, steel, or broken lead pencil points. One day in April, 1877, I had adjusted the transmitter—a soap box and a black sheet-iron diaphragm against a steel ball—to the utmost nicety, *i. e.*, an extremely loose contact, and closing the two wire ends leading to the battery, I suddenly heard a scraping sound coming from the transmitter. I had discovered that a microphonic contact could be vibrated by a current, and that such a transmitter would act as a receiver of sound as well.

"This analogy with the Bell telephone," he says, "struck me very forcibly, and immediately making a duplicate transmitter, two days afterwards I actually transmitted speech and music with these two simple contrivances, almost as simple as a lover's telegraph. This work was mostly done before, or after business hours, or on Sundays. I now tried all sizes of instruments, and various metals as diaphragms, and finding that distance would weaken the effect very considerably, hit upon the idea of placing the transmitter in the primary of an induction coil, thereby transforming the undulations into high-tension currents, passing these over the line wire, and re-transforming them again into low-tension currents at the other end to actuate the microphone receiver. No Bell telephones were used in these tests, but each instrument was used both for transmitter and receiver. My patent for this was issued Jan. 15, 1878, and was later re-issued. Without this, practical telephone work would be impossible. When, soon afterwards, I was introduced by a prominent Washingtonian, Mr. A. S. Solomons, to Prof. Henry, this great scientist was particularly pleased with the use to which I put the induction coil. I mentioned to him at the time that telephone circuits were found to be affected by parallel wires on which Morse signals were sent. He then related to me that he himself had traced signals on long lines between two wires which were a mile apart.

"I made some attempts to interest practical electrical men in the transmitter principle, and in Jan., 187[illegible], visited the New York local branch of the Bell Telephone Co., but they refused to pay a very modest sum for the invention, which was then not yet perfected. It was not until during the summer of the same year that, by request of Mr. Anthony Pollok, the attorney of the Bell company, Mr. Thos. A. Watson, general superintendent of the Bell company, visited Washington and examined the transmitter, when he immediately declared that his company would want it. As one of my conditions, I asked to become a member of their electrical staff, and a contract was closed in Sept., 1878, in New York. Returning to Washington, a few nights later, to prepare for leaving, I sank into a severe nervous prostration, which lasted seven weeks, and from the effects of which I suffered many years afterwards. Leaving the hospital, I went to New York to enter upon my new duties."

ELECTRIC RAILWAYS IN BERLIN.

The local authorities of Berlin are examining the projects of Siemens and Halske for an elevated railway, and the General Electricity Company for an underground system consisting of three lines.

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VOL. XII. NEW YORK, NOVEMBER 25, 1891. No. 186.

The discovery of magneto-electricity is the greatest experimental result ever attained by an investigator. It is the Mont-Blanc of Faraday's achievements.—Tyndall.

THE BERLINER PATENT.

NOT often has the issue of a patent elicited so immediate and widespread comment and discussion—in the columns of the press and in general conversation—as have attended that of Emile Berliner for a "Combined Telegraph and Telephone." The SUPPLEMENT to THE ELECTRICAL ENGINEER of last week gave the leading points of the specification and the claims in full, together with such facts touching the long-pending Berliner-Edison interference proceedings as were then at hand.

Berliner's application was filed June 4, 1877; Edison's, July 20, of the same year. The interference was declared May 27, 1880. Account had to be taken of Drawbaugh's application of 1880. If found entitled to a patent, that inventor would have had to be joined in the interference. Within the last three weeks—or more than eleven years after its declaration—the interference has been dissolved and two of the cases have been disposed of. The Commissioner of Patents denied Drawbaugh's application October 29, on the ground of public use for more than two years before its date. On the same day the interference was dissolved—Berliner having filed amendments—and the Commissioner directed the allowance of the Berliner patent. Mr. Berliner's amendments, the filing of which practically terminated the interference with Edison, date back to February, 1886; since which time the interference has, apparently, existed in form only. The Commissioner's attention was called to the readiness of the case for issue by Examiner Bissing, who, in his communication of October 29, characterized the application as "containing generic claims for the microphone and the art of microphony." Mr. Bissing said further, that in his opinion, it was "*of the highest importance that the term of the patent granted on this application should begin to run at the earliest possible moment.*" The Commissioner replied, on the same day, as follows:

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., Oct. 29, 1891.

EXAMINER BISSING: I have carefully read your letter of Oct. 29, 1891, concerning the application for patent filed by EMILE BERLINER June 4, 1877, for a combined telegraph and telephone. As this applicant has technically perfected his rights to the allowance of a patent, I think the allowance should issue, largely because well-settled principles of public policy forbid you to give any further opportunities for holding this application in the office. Very respectfully yours,
W. E SIMONDS, Commissioner.

It now remains to be seen what will become of the Edison application, now freed from interference.

There can be little if any doubt as to the scope of the Berliner patent. Its first claim is exceedingly comprehensive, viz.:

> The method of producing in a circuit electrical undulations similar in form to sound waves by causing the sound waves to vary the pressure between electrodes in constant contact so as to strengthen and weaken the contact, and thereby increase and diminish the resistance of the circuit, substantially as described.

This seems to include all types of transmitters now employed in practice; yet it may not prove exhaustive for the next seventeen years. It is worthy of note that the patent wholly excludes a possibly important class of variable resistance transmitters which depend for their action upon variations of the area of surface in contact, excepting cases in which such variation is produced by variations of pressure; a circumstance which perhaps may leave open a most fruitful field for the researches of future experimenters and investigators. Broad as the patent undoubtedly is, yet it constitutes a *species* rather than a *genus*, and is thus much inferior in scope to the Bell patent, which is truly generic. Until the now accepted theories of the propagation of sound and of electricity can be upset, it is hardly conceivable that articulate speech can be reproduced electrically without the employment of undulatory currents; but it does not seem improbable that research and ingenuity will arrive at a satisfactory method of producing the undulatory current other than that of variable pressure between electrodes.

Intimations have appeared in the course of the prevalent discussion on Mr. Berliner's patent, to the effect that it might perhaps ultimately be held void by reason of the issue to him of a prior foreign patent. There is apparently no foundation for such an expectation. The invention of Berliner, as fully set forth in his application, is to all intents and purposes identical with the microphone of Professor Hughes, the first description of which, published in May, 1878, nearly a year later than Berliner's application, attracted a great amount of attention in scientific circles throughout the world, and became the subject of a somewhat acrimonious controversy, as to the question of Hughes' priority, between Mr. Edison and Mr. Preece. No serious doubt existed, even at the time, among those well informed of the facts, as to the originality of Hughes's discovery of the microphonic principle; but, as it now appears, he had been anticipated in point of time by Berliner, whose priority over Edison has also been affirmed in the interference proceedings. As Berliner took no British patent prior to the date of Hughes's publication, he, of course, could not have had a valid one afterwards. He did, however, subsequently take a British patent through his agent, Lake (No. 91 of 1880), for a microphone, in which the scope of the invention is carefully limited to a movable electrode held against a stationary one by gravity. It will be observed, however, that the Berliner patent just issued involves an essentially different principle from this: that of a continuous pressure of one electrode against the other, a pressure which is varied solely by the action of the diaphragm in yielding to the impact of the atmospheric sound waves.

Respecting the extraordinary period during which the Berliner application has been held up in the Patent Office—14 years—and the possible effect of that delay in prolonging the monopoly of the American Bell Telephone Company by a similar period, that company is extensively accused of contributing to postpone the issue of the patent, aided by the inability of the Commissioner, under existing statutes, to force action within a reasonable time. If, as seems not unlikely, the charge be true, it amounts merely to saying that the Bell company has done all it could, under supposed legal rights, to protect and prolong its control of the telephone service; finding a convenience to its hands in the power to suspend the interference proceedings between two applications owned by itself. The morals or policy involved need not be discussed at this time. Yet it would be a public misfortune should the Berliner patent result in maintaining the company in undisturbed possession of its present field for 15 years after the termination of the Bell patent; a misfortune as enabling the company to exact such royalty as may please it for that period, and as exhibiting a defect in the existing patent laws which apparently provide no means for preventing unreasonable and collusive delay in interference cases. The question whether the Bell company is blameworthy—whether it ought or ought not to avail itself of its legal advantage—is one of casuistry rather than of business—more academic than practical. The important consideration for the electrical and general public is: What can be done to defeat the threatened prolongation of the Bell monopoly and what should be attempted in the way of legislation designed to preclude for the future the indefinite suspension of applications in the Patent Office?

We regret to observe a tendency, in some quarters to reflect upon the present Commissioner of Patents, Mr. W. E. Simonds, because information of the allowance of the Berliner patent reached interested parties before it reached the press and public. The allowance of an application is, as a matter of course, notified to the applicant or his assignee by the office; the issue of the patent following sooner or later upon the payment of final fees. This necessary practice accounts for the early information that reached some persons and not others. From all the facts now available, it would seem that Commissioner Simonds and Examiner Bissing bestirred themselves very soon after Mr. Simonds came into office to clear up and dispose of the case.

A large amount of litigation over telephone patents may confidently be looked for during some years to come, and it remains to be seen whether the American Bell Telephone Company will achieve, in the Berliner case, the conspicuous success that attended its prolonged fight over the Bell patent.

ELECTRIC MOTOR REGULATION.

The methods of regulating electric motors and of governing their action so as to conform to various conditions of service have probably only been equaled in variety and number by the methods designed for the regulation of dynamo electric machines, of which, indeed, they are in many cases the direct corollary. But as in the case of the latter, few of these methods have survived the test of extended use, and, as a result, it may be said that three or four methods of regulation at present cover the entire range of motor application. What the possibilities in this direction are may be readily discerned when we consider the various types of machines at present available and the various elements in their construction which can be utilized to bring about changes necessary for regulation. Such a scheme was very cleverly worked out some time ago by Prof. Francis B. Crocker in an admirable paper read before the American Institute of Electrical Engineers, and he demonstrated the possibility of devising methods aggregating more than a score in number. The discussion of that paper brought out still other methods, more particularly mechanical in their character. But that the field is still open for investigation is shown by the work of Mr. H. Ward Leonard, which he describes in detail on another page. For all such work, where both speed and power are constantly varying, as is pre-eminently the case in electric railway practice, a method of regulation such as that advocated by Mr. Leonard will do much towards increasing the efficiency of operation, and its effects will be felt, especially on roads involving heavy grades. Some other operations to which such a system will successfully lend itself have been well pointed out in Mr. Leonard's paper, and they form but a fraction of the many to which it is directly applicable.

LONG-DISTANCE TELEPHONY.

The practical limits to which telephony is confined at the present time are so thoroughly understood that the hopes for increasing the distances of practical transmission apparently can be looked for only in the reduction of the resistance of the lines and more particularly of their static capacity. It is the latter which is most generally lost sight of and which, as a rule, is ignored by those who have advocated ocean telephony. The speed at which an impulse can be transmitted over a line of given capacity is so well known that success in this direction with any method of transmission at present in use seems hopeless, but a most suggestive method is that brought forward by Mr. J. W. Gibboney, described elsewhere in this issue, in which he proposes to employ the phonograph as an intermediary to reduce the speed of transmission, and again to increase it to the original pitch of the voice at the other end of the line. While the practicability of this mode of transmission still remains to be proved, the method is one certainly worthy of consideration.

THE MEASUREMENT OF THE LOSS BY HYSTERESIS.

BY

Chas. Steinmetz.

WITH considerable interest I have read in THE ELECTRICAL ENGINEER of Nov. 11th the proposition of Mr. Th. Spencer, to determine the loss of energy by hysteresis by means of two specially-designed electro-dynamometers, though I hardly think that Mr. Spencer tried his method by applying it to actual testing.

Having spent a good deal of time myself with this phenomenon of hysteresis, theoretically and practically, I may be allowed to make a few remarks on this proposition. Reduced to its principle it means as follows: Let I_1 and I_2 denote the *effective* values of primary current and secondary current respectively, and i_1 and i_2 their instantaneous values. Let I denote the effective value of the resulting current (which is produced by combining I_1 and I_2 by the parallelogram of electric currents), that is, the effective value of $i = i_1 + i_2$. Then the two electro-dynamometers give the effective values, I^2 and $I I_2 \cos (I I_2)$.

Hence, it being impossible to determine by means of *two* instrument-readings the *three* unknown quantities contained therein, $I, I_2, \cos (I I_2)$, this method cannot give the absolute values of primary and of secondary current. Therefore it does not give the secondary or induced E. M. F., or, what is the same thing, the intensity of magnetization; that is, the number of lines of magnetic force per square centimetre to which the determined hysteretic loss corresponds.

But the loss by hysteresis depends largely upon the intensity of magnetization, and therefore, if this is not determined—as it cannot be done by the proposed method—the hysteretic loss tells just as little as does the current strength about the resistance of a wire, if the E. M. F. between its terminals is not known. Therefore it is not possible to determine the hysteretic loss by less than *three* electro-dynamometers, because the determination involves the knowledge of *three* unknown quantities. Besides, this method has the serious objection, that its result is really not the hysteresis proper, but includes the loss of energy caused by the electric resistance of primary and secondary coils and cannot be freed therefrom, because both currents remain unknown.

Now in a well-designed transformer, especially of large size, the loss in the copper for full load is almost as great as, or even greater than, the loss in the iron (2.0 per cent. against 1.5 per cent., Ganz & Co. 20 h. p. converter). Hence the loss in the copper must be subtracted from the whole loss, to get the hysteretic loss, and for this the currents must be determined.

The self-induction of the secondary circuit can *not* be neglected either. For the hysteretic loss is the difference between the primary and the secondary energy, and a rather small difference at that. Therefore a small error in the secondary energy, as it is caused by neglecting the self-induction, must cause an enormous error in the value for the hysteresis. This I consider the reason we have not yet got exact values for the hysteresis in a converter at full load. This explains the alleged decrease of hysteresis for increasing load, which, theoretically, is beyond comprehension, for it cannot be understood what difference it can make for an iron molecule, whether some trillion molecules away a secondary current circulates or not, if the iron molecule undergoes the same magnetic cycle. The self-induction of the instruments has to be taken into account also, and this depends upon current strength.

I have tried several times to use multiple electro-dynamometers, that is, instruments fed with two currents through parallel wires, but have always been obliged to abandon them as entirely unreliable. For the two parallel wires of the instrument, fed with separate currents, constitute a real transformer, or rather each instrument two transformers, one being the fixed, and the other the movable coil, and therefore act and react upon each other, either current inducing E. M. F. in the circuit of the other. To calculate even this mutual induction and reduce the readings for it, is far too complicated to be of any practical value, and is impossible if the strength of the two currents is not known. Considering all this, we see that the determination of the hysteresis by means of electro-dynamometer is far more difficult than assumed.

If the secondary circuit is open there must be a voltmeter, a wattmeter and an ammeter, that is, three instruments, in the primary circuit. Besides this, means must be provided to determine the exact number of pulsations of the alternating current, either by reading the speed of the dynamo alternator proper, or the speed of synchronizing devices. All the resistances of the primary coils and the coils of the instruments must be known, and also the self-induction of the different coils of the instruments.

In case of tests for hysteresis with secondary circuit closed, we need at least a wattmeter and a voltmeter in the secondary—if it is almost non-inductive—and an ammeter and a wattmeter in the primary circuit, at least four instruments, and cannot expect any great accuracy, because of the great error in the result, caused by a very slight error in one of the readings.

I wish also to make a few remarks on another method for the determination of hysteresis, lately proposed by Ewing, to determine the hysteretic energy by comparing the heating of a converter with that of an apparatus exactly like it, but with bifilar-wound primary and secondary coils to produce no magnetism, and supplied with continuous current through a third coil. As soon as the temperature of both apparatus remains stationary at the same point, the energy expended by the continuous current in the third coil measures the hysteretic energy in the other apparatus.

Unfortunately, this very ingenious method can be applied only between very narrow limits; for it can give exact results only in the special case where the iron of the magnetic circuit is *completely* and *evenly* covered by the primary and secondary coils. In all other cases it must give *wrong* results.

Take, for instance, a Westinghouse converter. Build an apparatus exactly like it and of the same material, with its coils connected in series to those of the first converter, but bifilar-wound, and supply it with continuous currents through a third coil. Now even supposing both apparatus consume exactly the same energy, then in the converter a great part of the energy is consumed in the iron; in the other apparatus none is consumed in the iron but all in the copper. Hence in the converter, the iron will be hotter and the copper cooler than in the other apparatus, with the same consumption of energy, and if a thermometer be placed on the iron and adjusted for equal stationary temperature, too large a value for the loss of energy by hysteresis is obtained, while if the thermometer is placed on the copper, it gives too small a result.

Hence it almost looks as if the only way to determine the hysteretic loss of a converter at full load is to put it in an ice-calorimeter, measure the heat given off, and subtract the heat developed in the copper, derived from current-strength and resistance. This way is anything but promising.

HANDY AND PITHY.

A READER of THE ELECTRICAL ENGINEER writes us: "Of late, though I take several electrical journals, yours is the only one that I regularly open. It was a felicitous conceit to adopt so convenient a form. I like the editing, too."

ELECTRIC RAILWAYS AT THE FRANKFORT ELECTRICAL EXPOSITION.

There were several interesting systems of electric railways exhibited at the Frankfort Electrical Exposition which are worthy of notice.

Two overhead systems were in practical operation, that of Siemens & Halske, of Berlin, and Schuckert & Co., of Nüremburg. The Siemens & Halske system was operated between the Exposition and the Opernplatz. The accompanying illustration shows clearly the peculiar sliding contact used by the company.

The system of Schuckert & Co. was operated between the Main Exposition and the Marine Exposition on the River Main. These cars have trolley poles similar to those of the Short system, and make a sliding contact with the trolley wire.

The Siemens & Halske road also had a storage battery car which was used mornings and evenings, before and after the dynamos at the Exposition were stopped. This car had two motors of 7 h. p. each, one on each truck. The armature was connected to one set of gears, and these were connected by means of chains to the axles, thus avoiding the double-reduction gear. The chains were of peculiar construction, being made up of small tubes of steel with rods and external connecting straps, admitting of great flexibility. This chain ran in oil, making no noise. The armature speed was 1,000 revolutions per minute when the speed of the car was 12 kilometres. This car was run four hours in the morning and two hours in the evening, while the overhead system was not in use. The storage batteries were of the Tudor type, and there were 162 cells connected in series. The potential of the motors being

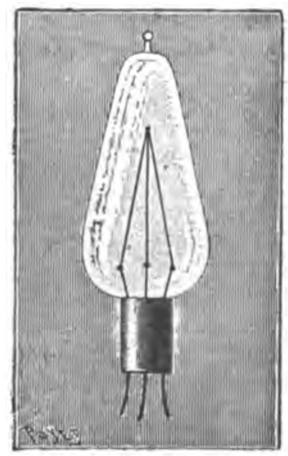
Siemens & Halske Car at the Frankfort Exposition.

300 volts, a large number of small cells were used as a make-shift because the motors had been built for the overhead system of 300 volts, the capacity of the accumulators being 60 ampere hours. There were three connections used in changing speed. On starting, the 4 sets were connected in parallel; when running slowly the cells were connected in two series, and at full speed all the cells were connected in series. The battery for this car weighed 2 tons. The total weight of car loaded was 10 tons, including 40 passengers. The cells of the battery car were charged in 3 set series with a charging current of 48 amperes.

The closed underground conduit system of Mr. C. Pollak, of Paris, was of great interest to all. Mr. Pollak had a working model of his system on exhibition in the Railway Exhibition Hall. This system will be exhibited on a large scale at the World's Fair, at Chicago, in 1893, and Mr. Pollak claims he has several roads now about to be constructed in Germany and France. The "Helios" Company, of Köln, also had a working model on exhibition of a system of rapid transit to be used between Vienna and Budapesth.

THREE FILAMENT INCANDESCENT LAMP FOR MULTIPHASE CIRCUITS.[1]

Anticipating the time when multiphase circuits will become general, M. Dolivo-Dobrowolsky has constructed an



Three-Filament Lamp for Multiphase Circuits.

incandescent lamp adapted to be placed on such circuits. The lamp, which is illustrated in the accompanying engraving, consists of three filaments joined at their tops, the free ends being connected to the three circuits of the multiphase transformer. For the proper operation of the lamp, the current passing through each one of the filaments must be equal, at every instant, to the sum of the currents in the other two filaments, and this is exactly the property of three-phase circuits.

THE NEW GERMAN PATENT LAW.

According to the provisions of the new German patent law which went into effect October 1st, an invention is considered new if at the date of filing the application for patent it has not been so described in public prints within the last century, or so publicly employed in the German Empire that the use of the same by persons skilled in the art appears possible. The official foreign patent specifications are only considered equal to public prints after the lapse of three months from the date of publication, in so far as the patent is applied for by the foreign patentee or his legal successor. This exception only refers to the official publications of those States in which (according to an official publication) reciprocity is guaranteed.

Another new departure is a "Law for the Protection of Useful Models," by which all kinds of tools and implements which cannot be patented can be protected by this law—even the subjects of refused patent applications can now in many cases be protected. A most important provision is that applications are accepted without examination. The protection lasts six years, and promises to prove of value for all kinds of small inventions not perhaps worth patenting fully.

1. *La Nature.*

A MOTOR OPERATING AUTOMATICALLY AT ANY DESIRED SPEED OR TORQUE AND WITH MAXIMUM EFFICIENCY UNDER ALL CONDITIONS.

BY

H. Ward Leonard

In the operation of electric motors there are three principal factors to be considered, the speed, the torque and the efficiency. Under any variations in power the efficiency should remain as nearly constant as possible. For one class of work it is desirable to keep the speed constant when the torque varies. For a second class of work it is desirable to keep the torque constant at one particular amount when the speed varies. For a third class it is desirable to operate at many different speeds, and yet automatically at any particular speed desired regardless of the torque. For a fourth class it is desirable to operate at many different torques and yet automatically at any desired torque regardless of the speed; and for a fifth kind it is desirable to keep the amount of power supplied constant, regardless of a change in torque, that is, so that if the torque changes by the requirements of practice, the speed would automatically change so that the power consumed would remain constant.

The shunt-wound motor, operating on a constant potential circuit, is well adapted to the first class of work mentioned, where but one fixed speed is desired, practically regardless of the torque and with a practically constant efficiency.

The second class of work mentioned, having one particular constant torque and a speed variable at will, cannot be performed by existing electric motors without great sacrifice of efficiency. In this class of work we find hoists lifting a constant weight, certain printing presses, swing bridges, stamp mills, pumps, etc.; that is, such work as requires that we should start up from dead rest with full torque and run at any desired speed with the same torque and with perfect efficiency.

The third and fourth classes of work are more common than would at first appear evident, but since neither the steam engine nor the water-wheel can be operated under conditions where both speed and torque will vary, and where the speed or torque can be held automatically fixed at any point desired, regardless of variation of the other, we do not find work of this kind existing in such shape as to be operated by an electric motor instead of some other power. Nor has the electric motor been available for such duty heretofore. A familiar instance of the third kind of work is met with in the printing of fabrics, where the presses have a large number of rolls upon which the torque depends, and the speed of the presses must be varied as desired, and yet at any given speed must hold that speed constantly, regardless of the number of rolls set down, that is, regardless of the torque. Similarly, lathes, drill presses, wood-working machinery, etc., belong to this class. Certain variations in the speed are possible by existing methods by the use of cone pulleys and equivalent devices, but no motor of any kind has heretofore existed which, directly applied, would conform to the requirements of this kind of work.

The fourth kind of work has, as a familiar example, the passenger elevator, where the weight, and consequently the torque, is variable, and where at any torque the speed should be controllable at will, with constant efficiency. Another example is the pumping of water against a variable pressure with the speed controllable at will, and independent of the pressure. This result is not obtained directly by any motor to day.

The fifth class of work, where the speed is automatically varied to keep the power consumed constant, no matter how the torque varies, is not met with in practice as far as I know, yet oftentimes we may have a constant source of power from which we wish to get a torque variable to the requirements of a variable load and do not care particularly about the speed. An electric street railway operated by water power is a familiar example of this class of work.

It will be seen from the above that of the five principal classes of work there is only one, namely, constant speed and variable torque, which we can take care of with reasonable efficiency and from our existing supply circuits.

It is well known that when a street car is first started and is scarcely in motion the actual power represented by such motion is almost nothing, for, although the pounds pull is large, the feet per minute is extremely small; consequently the power required must be exceedingly small. What do we find in practice? We find that in order to develop a power of but a fraction of a horse-power we must, on account of the slow speed demanded, develop about 30 h. p., and then waste about 98 per cent. of this h. p. in order to utilize the remaining 2 per cent. in the way it is desired. The efficiency of the modern electric street-car is not probably more than 2 per cent. when just starting from dead rest and moving at the rate of one-half foot per second.

When we come to investigate this, we find that the explanation is that in order to get the necessary large torque with freedom from excessive sparking we must have a very large current in a nearly constant field; and since our E. M. F. is constant we must use an amount of power which will vary almost directly with the torque, and will be regardless of the speed. Or, in other words, the efficiency of the motor will vary directly as the speed with an efficiency of perhaps 80 per cent. at full speed.

As a result of my investigation of this subject I have concluded that the operation of electric motors should conform to what, apparently, is a new law and which may be stated as follows:

Vary the voltage as the speed desired.

Vary the amperes as the torque required.

In other words, make the speed dependent upon the voltage only and independent of the current, and make the torque dependent upon the current only, and independent of the voltage. Since the product of the speed and torque represents the work being done, and the product of the volts and amperes represents the power supplied, it is evident that if we can operate in conformity to this law, we shall have a constant efficiency under all conditions, disregarding, of course, the small fixed losses in the field and armature.

One way in which this law can be followed is to supply the field of the motor from one source of electric energy and supply the armature from another source, the E. M. F. of which can be varied. It will be noticed that when the speed is fixed a fixed voltage will be necessary in order to conform to the law, and the shunt motor is found to conform perfectly to the law; but it is the only motor I know of which does conform to the law which seems to be generally applicable.

A simple case will be the operation of a printing press for printing fabrics. Suppose the press has 10 rolls, that is, the torque will vary from 1 to 10 in amount. Suppose also that it must be run at any speed from that represented by 1 to that represented by 20, and at any speed it must hold its speed constantly, whether 1 or 10, or any intermediate number of rolls be brought into use. Also that the efficiency must be independent of the speed or torque. In order to conform to the law in a simple way, we will install a generator A and motor B of the same size (see Fig.) and connect their armatures by two conductors. We will supply their fields from a small separate exciter, C, in the shape of a shunt-wound dynamo. In the circuit leading to the field of the generator we will place a rheostat D. If now we drive our generator at a constant speed, the E. M. F. it will produce will depend upon its field, which in turn will depend upon the amount of resistance in the rheostat in its field circuits. The strength of the motor field is constant, being supplied by the constant E. M. F. exciter. Now, evidently the speed of the motor will depend solely upon the E. M. F. supplied to its brushes, and this can be varied from 0 to the maximum limit by varying the rheostat, which will preferably be placed beside the motor itself. The current will automatically vary in proportion to the torque, the speed will vary directly as the voltage and the efficiency will be constant and independent of the speed or torque.

If we wish to operate an elevator from central station conductors of constant E. M. F., we supply a shunt-wound motor mechanically connected directly with a generator, whose armature is connected to the armature of the elevator motor. The field of the generator is supplied from the central station conductors, but a loop goes up to the elevator car, where a rheostat and reversing switch Q is placed, so that the E. M. F. of the generator can be varied and reversed at will. The field of the elevator motor is excited from the line constantly.

It will be evident that we can control the elevator perfectly from the car and run in either direction, at any desired speed, and with perfect efficiency. It is worthy of notice that the non-sparking point is entirely independent of the speed, and that for any particular weight the non-sparking point is absolutely fixed and independent of the power used. Also that, since the maximum weight alone determines the maximum amperes, it will be impossible to send more than the normal full load in amperes through the armature; consequently the liability of burning out of armatures is reduced to a minimum. The elevator in coming down generates current to assist the central station, and since the efficiency is practically constant under all conditions, and since as many foot-pounds of work are done by the elevator in descending as it requires in ascending, the consumer will in reality pay only for the energy wasted in charging the fields, in heating the armatures, and that represented by the friction of the gearing, which will be the least possible. The starting up of the elevator requires a minimum of power, and hence does not subject the central station to large, sudden fluctuations of load.

Suppose we want to operate a swing bridge by an electric motor. We connect as in the case of a printing press, but instead of a hand-field rheostat we use an automatic field rheostat, such as is used by the Edison Company. We place an amperemeter in the armature circuit of our motor, and when the amperemeter needle indicates full load it touches a contact leading to the relay magnets of the automatic rheostat, which causes it to throw in resistance in the field circuit of the generator and reduces its E. M. F. Similarly, just below full load, the amperemeter needle makes contact, closing a circuit in the automatic rheostat so as to throw out resistance and raise the E. M. F. of the generator.

To start up the bridge we insert all of our resistance in the field of the generator and have, let us say, no volts. Now we close the main-line switch to the motor; we will have no current; hence the amperemeter needle will be on the lower contact, which will gradually throw out resistance and cause the generator to generate an E. M. F. The current will increase and will finally cause the needle to leave the lower contact. The full torque is now being developed and the bridge, if the motor be of proper size, will start to move. As it does so, the counter E. M. F. of the motor will tend to reduce the current, but this will cause the needle to again make the lower contact and raise the E. M. F. and speed and hold the current and torque constant.

Thus, the bridge will start from rest with a minimum of power but full torque, and will gradually accelerate in speed until the full E. M. F. and speed of the motor is reached. To vary the speed by hand we merely move the amperemeter needle to make either contact desired. In case the bridge should meet an obstruction which would slow it down, the amperes would not increase, but would remain constant, as the volts would be immediately and automatically reduced to just that amount necessary to keep the amperes constant. With this arrangement it will be practically impossible to overload the motor armature.

Another good application of this method of keeping the torque constant will be in any case where a tool is cutting certain material which may vary in hardness or when the feed may vary. If the torque be kept constant it will be impossible to break the cutting tool or injure the apparatus. An electric coal-cutter is a case in point. The cutter may be advancing through slate, fire clay or coal, and occasionally it will meet a layer of hard iron pyrites, known in the mines as "sulphur." This may stop the cutter-bar entirely, and with an ordinary or series or shunt motor the result would probably be a burnt-out armature. With the system I have described the current would be constant in any event and the cutter would automatically go faster in soft material and slower in hard material.

In pumping by an electric motor operated on this system the head alone determines the torque, and hence the current. Consequently, for any lift the non-sparking point will be fixed and the number of strokes per minute can be controlled at will from 0 up to the maximum by varying the volts.

For operating an electric railway we will place a shunt-wound motor on the car, and directly driven by this motor will be a special generator, which will be connected to the electric motor below the car. It is evident that the generator and working motor armatures may be wound for any voltage desired, say 20 volts, which will make the problem of insulating the street-car motor an extremely simple one. If desirable, we can supply several cars of a common train from one special generator on the forward car. With this outfit we will be able to take any car up any practicable grade or around any curve with no more power than is required to move the car on a level, and always consume the same power, regardless of weight, grades or curves. That is, the automatic increase of current, to take care of any increased torque, will be compensated for by a corresponding decrease in the volts and speed. We may start a car up on any grade or curve with but a small fraction of the power required for normal speed on a level.

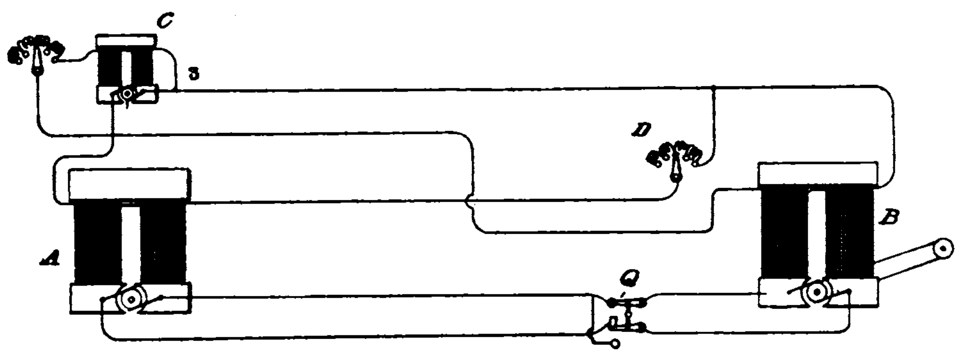
I wish to call attention to a very important development leading out from this, namely, that we will be able to use alternating currents for operating our street cars, for it is well known that the ordinary alternating current generators will operate perfectly as motors, if the speed and torque be kept constant. Since by this system we can, from a constant torque and speed, get any other torque and, automatically, a corresponding speed, we shall be able to run street cars perfectly by alternating currents. This again will enable us to dispense with trolleys, conduits, storage batteries, etc. We will place between our tracks, in manholes, converters whose primary pressure can be anything required for proper economy and whose secondary will be, say, 15 volts. This secondary circuit will connect directly with the rails. The road will be divided in sections, each a few hundred feet long, and each section will be supplied by its own converter.

This system also lends itself very readily to the transmission of power. We may transmit by alternating currents and the alternating current motor running at a constant speed and at a nearly constant torque will drive special generators to operate hoists, pumps, locomotives, etc., at the varying torques and speeds demanded by practice, and yet without subjecting the alternating-current motor to a sudden or wide fluctuation in its torque and without any necessity of varying its speed. With this system of operating electric motors there seems to be no work met with in practice which cannot be perfectly performed.

On first consideration, the additional apparatus necessary would seem to make the system prohibitory in practice; but the capacity of the present single motor is greater than the combined capacity of the apparatus this system would require, and the capacity of the prime motor is very much reduced.

In order to reduce the first cost to a minimum and yet secure the advantages of different automatic speeds and high efficiency I have devised two modifications of the arrangement described above. The first is adapted to power in which a smooth, efficient acceleration of a load from rest is required, as in the case of passenger locomotives and elevators. The second case is where various automatic speeds are desired, but no especial importance attaches to the starting of the load from rest, as is the case in machinery in general.

For the first case we have the trolley system of electric street cars as the most important. Let us suppose we have two motors of 15 h. p. each for the car. We find that for full speed upon a level we require about 15 amperes at 500 volts. Upon heavy grades we find that about 50 amperes are required, and, as before, we have 500 volts. With this consumption of energy we find that we get a speed upon the heavy grade which is about one-quarter of the speed upon a level. In order to operate upon my system, let us place upon the car a motor generator, the motor part of which is wound for 500 volts and $12\frac{1}{2}$ amperes and the generator part of which is wound for 125 volts and 50 amperes. The fields of the motor and generator part are distinct and are wound for 500 volts, as are the fields of the two propelling motors, under the car. All these fields are supplied from the 500 volt trolley circuit. In the field of the auxiliary generator is placed a rheostat.



THE LEONARD METHOD OF MOTOR REGULATION.

Now, suppose the car at rest upon a grade. The motor generator is running, but the generator has a very weak field. Its armature is connected by a controlling switch to the propelling motors. We now gradually cut out resistance from the generator field circuit and finally get about 20 volts at the brushes of the generator. With this E. M. F. we get sufficient current to produce 50 amperes through the armatures of the propelling motors in a saturated field. This gives us the full torque and the car starts at a speed of, perhaps, half a foot a second. This speed can be maintained constantly and indefinitely and the consumption of energy will be less than 2 h. p. This is less than 3 amperes from the trolley line. In practice, however, the speed will be rapidly but gradually accelerated until we have 125 volts upon the terminals of the propelling motors. We will now be running at one-quarter speed and will be consuming 125 volts and 50 amperes, that is, $6\frac{1}{4}$ K. W. instead of 25 K. W. to get the same result with existing motors. To put it another way, we will not be using as much energy as is represented by the 500 volts and 15 amperes necessary for full speed on a level.

The next step on the controlling switch will disconnect the armatures of the propelling motors from the auxiliary generator and put the two armatures in series across the trolley line direct. We will now go at a speed represented by 250 volts, that is, one-half full speed. The next step of our switch will place the two armatures in multiple across the 500 volts, and the next and last step will place the 120 volt auxiliary generator in series with the main central station generators and give us 625 volts on our armatures and a correspondingly increased speed. We will be able to go up a grade of six to eight per cent. at full speed, with 50 amperes and 500 volts, which, with the present motors, gives us only about one-quarter of that speed.

Under this arrangement it will be noticed that the only apparatus which could be called additional is the small motor of 500 volts for the generator part of our motor generator, which is useful not only for starting, but for full speed also. In stopping the car we have an electric brake action delivering back energy to the line at full efficiency and not through a rheostat, as at present.

If we have a train of, say, three cars, so that we have six motors, we can start from rest with sufficient smoothness by placing all six armatures in series, which will give us something less than one-sixth speed as the first step. Then we can place three in series with two multiples, which gives us one-third speed. Next, two in series with three multiples, which gives us one-half speed; and finally all in multiple, which gives us full speed. Under such conditions, we can dispense with the small converting plant altogether.

For an elevator requiring, say, 15 h. p. we will put in a motor generator of 3 h. p., with which we will control the starting and stopping and the operation up to one-fifth of full speed. Then for full speed we will connect direct to the line and operate without any conversion of energy.

For power in which smoothness of motion in starting and stopping is not essential I have devised a new system of distribution as follows: Three dynamos, all having the same current capacity and having voltages of 62½, 125 and 250 respectively, are placed in series and from conductors led off in multiple one from each terminal of the machines. These conductors will have potentials which can be represented by 0, 62½ 187½ and 437½. Let us now take a shunt-wound motor, and, disconnecting the field from the armature circuit, excite the field from the outside two of the four conductors, that is, by an E. M. F. of 437½ volts. By connecting the armature terminals to the four conductors in various ways we shall be able to operate in either direction at six different automatic speeds represented by the following voltages: 62½, 125, 187½, 250, 275, 437½. By varying the field strength of the motor we can, if required, get any intermediate speed.

In many cases two dynamos will answer, one of, say, 110 volts already in use for incandescent lighting, and a second of, say, 30 volts. With this arrangement we could run in either direction and with automatic speeds represented by 30, 110 and 140.

With the four-wire six-voltage system of distribution in a shop we can take out all countershafting, belting, pulleys and gears, if desired, and place a motor upon every tool, which we can operate in either direction at any automatic speed desired. Lathes, planers and all tools can be perfectly operated, and by getting rid of all countershafts and belts we can introduce the greatest of modern tools, the traveling crane, which we will also operate from our general system. We can also readily operate ventilating fans, hoists, elevators and factory tramways from the system.

The addition of one dynamo and one new conductor to any existing three-wire system will probably give all the flexibility required to meet practical conditions of varying speeds. For the alternating system a synchronous motor driving our three continuous-current generators will give us the four-wire system in any distant factory or town. For 500-volt street railway circuits a small motor generator plant for the slow speeds and a direct connection for full speeds will give us perfect results. For storage battery work we have the most perfect condition, as we can get any E. M. F. desired, with a corresponding speed, while keeping the field separately excited.

Now, that we have the rotary field at command, I think I may safely assert that the time is not far distant when we shall have transformers which will, without motion, convert an alternating current in the primary into a continuous in the secondary; and this seems to me to be the ideal system of the future, that is, one in which energy will be transmitted by alternating currents of constant E. M. F. transformed without motion into continuous currents for use at the translating devices and used where motors are concerned, in conformity with the law of efficiency for motors: Vary the voltage as the speed desired; vary the amperes as the torque required.

AN AMERICAN PLANT IN MADRID.

An exhaustive account of the installation of the electric light plant in Equitable Life Assurance Company's Building in Madrid has been written and published in pamphlet form by Don Francisco Rojas y Rubio. Detailed descriptions are given of the engines, dynamos, switchboards, measuring and testing instruments, etc. Mr. W. T. Wheeler, an old New Yorker, who had charge of the fine U. S. plant in the Equitable Building in this city, and has installed other plants for the Equitable Assurance Co., has had charge of this important piece of foreign work.

FIRE HAZARDS FROM ELECTRICITY.[1]—II.

(*Concluded.*)

BY C. J. H. WOODBURY.

As the objection to overhead wires is largely based upon their unsightliness, so, on the other hand, the safety of underground wires is far more an assumption than a reality. The maintenance of insulation from the earth with currents of high electromotive force seems to be impracticable, even when the material of the conduit, as well as the covering upon the wires, is of high resistance.

In addition to the grounds on the buried wires, which may be the primary cause of difficulties elsewhere, there have been numerous destructive explosions wherever underground wires have been used. These explosions have been generally, and I believe incorrectly, ascribed to leakage of illuminating gas into the conduits. Even if there was such a leakage, there would not be any arc or undue heating of wires causing an ignition of the gas unless there was a connection to earth, and in such a case the explosions would vary in force and only be severe in case of the coincidence of a certain mixture of gas and air.

As these explosions have always been of a violent nature, we must look elsewhere for a cause which will always produce a high detonation; and this is accounted for by the presence of water in the conduit. Water being readily dissociated by electrolysis into a highly explosive mixture, an explosion would occur whenever the supply of water diminished sufficiently to produce an arc.

It is, however, undoubtedly true that gases from sewage as well as illuminating gas penetrate into conduits, and the lead covering on the insulation of wires in conduits is in some instances actively attacked from such causes.

In one city, where there are numerous underground telephone wires of this class, the corrosion of the lead covering was stopped by forcing sulphureted hydrogen gas into the conduits, forming a sulphate of lead on the outside of the coating. Some of the gas escaped, causing loud calls summoning the local Board of Health for gross dereliction of duty, but all complaints were appeased by the gentle hand of time, which wafted the unwelcome perfume away.

It should not be forgotten that the network of wires over the cities has been of great service in robbing the lightning of its dangers, more largely by induction than by dividing the charge and conducting it to earth. It is a fact that injurious effects from lightning in cities have been diminished of late years, and notwithstanding the density of occupation by buildings, they are far less than in the country.

In the present state of the art overhead wires must be recognized as necessary for the maintenance of electrical service. The few instances where they are put underground are in accordance with peculiar conditions and scarcely numerous enough to be considered as an exception to prove the rule.

Wires should be carried well above buildings and attached to fixtures rather than directly to the buildings themselves, being placed high enough not to interfere with firemen or others passing over the roofs. They should also be clear of other wires and protected with dead guard wires whenever there is any possibility that they may fall and come in contact with other wires.

The question of the insulation of such outside wires is far from being a settled one to the extent of actual practice. The greater part of the insulating material on these wires has become so deteriorated as to present but little electrical resistance, and it is necessary to place wires in such a way that the reliance will be upon the freedom from contact with other conductors rather than upon the insulation itself.

An insulating material upon outside wires should be waterproof and also able to resist the severe and almost continuous abrasion liable to come upon them, and where these wires enter buildings they should be bent in what is termed a water loop, so that the immediate approach to the building shall be upwards. They should also be provided with a double-pole switch capable of being operated from the outside, entirely cutting off all electrical connection from the inside of the building when so desired.

Whenever outside underground service is in use, still greater precautions are necessary at the entrance of the building. It is essential that there should not be any free opening from the cellar of the building to the conduit, and that the insulation of the wires should be maintained at this point and up to some suitable location where a double-pole switch can be placed.

The greatest danger from wires outside of buildings is that due to contact with other electrical wires, imposing upon them currents of greater volume than they can withstand, and heating the various parts to such an extent that the injury is not limited to the mere fusion of the coils of such apparatus, but the surrounding combustible material is ignited.

On account of the various widely differing characteristics of these foreign currents, there has not as yet been found any single device which will protect them against injury. These elements of defence have been carried to great perfection by the telephone companies.

The form of apparatus is fourfold in its nature;—first the ordi-

1. A lecture delivered at Cornell University, Nov. 6, 1891.

nary serrated lightning arrester, which is generally able to protect the system by reason of the extent to which the lightning is divided by the numerous wires in its course, and, as has been mentioned before, this lightning is very often inductive in its nature rather than a direct stroke.

Second, the telephones are protected against currents originating from incandescent lighting or power circuits by means of pieces of easily fusible wire about four inches in length inserted in the line of the telephone system. These wires are enclosed in glass tubes, not merely to protect them from injury, but also to prevent any damage being caused by the hot metal of the fuse igniting anything when it is thrown about by the explosive violence which occurs whenever a heavy current melts it.

A similar device consists of a strip of tinfoil rolled up with asbestos paper and forming a part of the circuit, the tinfoil being instantly vaporized by an abnormal current.

Third, for protection against the currents proceeding from arc lighting apparatus and those used for the transmission of power, particularly the overhead trolley system, the most efficient means has been the air cut-out, consisting of two pieces of gas carbon separated a very short distance by means of a thin film of mica containing perforations. One of these pieces of carbon is connected to the earth and the other forms a part of the circuit. Whenever a current on a grounded circuit, having a tension of 350 volts, passes along the telephone circuit, it leaps the narrow space separating the two carbons, and, forming a very short arc, continues to the ground. Small bits of easily fusible metal are inserted in holes in the carbon, and, if the current is maintained for any particular length of time, the metal becomes melted and establishes a conductor of low resistance to the earth. A film cut-out can be used for the same purpose, but in this case is not quite so suitable because of the necessity of readjustment in every case where it is called into operation.

Third, another class of accidents are those arising from a cause more difficult to manage, and that is what are known as sneak currents, being generally foreign currents connected with the system by something serving as a shunt of high resistance, so that the current is very small, but yet enough to injure the electro-magnets and also to cause fire when they are maintained for a long time; for it should be remembered that the insulating material upon the wires used in electrical apparatus is also a non-conductor of heat, and it is not possible for them to safely conduct as great currents, as if they were not covered with insulation and were exposed to the air, allowing the heat to pass off by radiation instead of becoming cumulative.

The only form of apparatus which has thus far controlled these sneak currents is simply a ball, principally composed of wax, and about half an inch in diameter, held against the electromagnet by a strip of spring metal. Whenever the electromagnet becomes warm this ball softens, and the movement of the spring operates a switch which shunts the telephonic apparatus out of circuit.

There have been a great many devices invented for the purpose of protecting telephonic circuits, but many of them involve the introduction of electromagnets in the circuit,—a measure which would interfere very much with the service on account of the impedance given to the undulating currents to an extent that would diminish the clearness of the transmission of speech by the telephone. They are frequently of such large dimensions that it would not be practical to apply them to the switchboard of any extensive central station. Moreover it is found by experiment that these devices do not control the whole range of foreign currents liable to be met with at any instant in the telephone service.

The method which has been described, however, furnishes the most satisfactory results in actual service, being the outcome of investigations of electricians connected with the telephone companies,—corporations whose interests are far greater than those of any individual, for it should be remembered that the telephone companies own all the apparatus.

The installation of conductors for arc lighting circuits inside of buildings should be made with the utmost care. The use of the high electromotive force for arc lighting imposes conditions of insulation far more severe than those of incandescent lighting. Not only should the wires be covered with an insulation which is waterproof, if there is the least danger of water or dampness reaching the wires, but wires of opposite polarity should be separated at least a foot apart.

The specifications for insulation usually require that it will not fray by friction and will stand a temperature of 150 degrees without softening, and to this should be added that the insulation shall withstand as low a temperature as it will ever be exposed to without cracking.

Whenever wires are run in places liable to dampness, reliance should not be placed on the insulation alone, but the wires should be fastened to glass or porcelain insulators, and wherever wires pass through floors, walls, or partitions, they should be further protected by insulating tubing projecting on both sides. The lightning arresters should be grounded outside of the building, and preferably connected to a water pipe.

Inside wiring on incandescent work also requires especial care. All parties are agreed that no wires smaller than No. 18 Birmingham wire gauge or No. 16 Brown & Sharpe should be used. These have a nominal capacity of conducting five amperes of current, but the limitation of size of wires depends on their position, as the resistance is converted into heat, and exposed wire will safely carry a greater current than when confined behind mouldings or in tubes, the ordinary ratio of practice being one and two-thirds.

No doubt some of the mishaps attending the use of underground wires have been due to the heat of the wires evaporating volatile matters in the insulating material. On shipboard, wires should be tinned before the insulation is applied, in order to prevent any tendency to corrosion. Whenever wires are laid in moulding, there should be a strip at the back in order to prevent the wire from lying against the wall.

Imbedding of wires in plaster is not generally endorsed; but improvements in insulation will render this more permissible, although in any case such wires are subject to interference caused by contraction and settlement of buildings, and furthermore they cannot be arranged to provide for additions and alterations to an electric plant installed in a building.

Dr. A. F. Mason recently informed me of a contract to install 48½ miles of electric lighting wire in a building under a contract guaranteeing the wires to resist cement, lime, and salts found in the materials used in the construction of fireproof buildings, and to sustain an insulation of 1,000,000 ohms for one year.

The usual methods of conducting electrical wires, to which reference has been made, are confessedly of more or less temporary character, and wholly inconsistent with the well-established position of electrical illumination in its practical applications, and such methods of installation are necessarily more or less obtrusive in the manner of their construction, interfering with methods of decoration.

Wires have sometimes been concealed in insulating tubing known as interior conduits. These tubes are placed out of sight in a building, comparable in arrangement to a system of gas pipes. The wires are run through these tubes by inserting a stiff steel tape with a knob at the end, which is easily pushed through any portion of the tubing. Afterwards a line is drawn through, and then in turn the electric wires. These wires can be inserted or withdrawn without disturbance to the system. Such tubes, when made of incombustible waterproof material which is a non-conductor of electricity, can safely be installed in the manner indicated, and serve a very useful purpose in widening the field of applications for electric lighting.

Fuses should be double-pole mounted on incombustible bases, and should be used whenever the diameter of the conductors changes.

Each cut-out should interrupt the passage of the current in excess of the amount to which any portion of the apparatus which it protects is adequate to transmit, and the strip of fusible metal should be marked with the current which it will transmit.

There should not be any joints or fuses or switches in rooms containing inflammable vapors or highly combustible material fine enough to float in air.

Arc lamps should be provided with globes with tight stands, so that sparks from the carbons shall not reach combustible materials. They should also be provided with some stop which will render every assurance that the lower carbon will not fall in case the usual clamp should not secure it. In addition to the hand-switch they should also have an automatic switch which will shunt the current around the carbons if they should fail to feed properly.

Incandescent lamps are not usually a source of hazard in themselves as directly causing a fire; yet there are some precautions to be observed, the most important being the prohibition of wrapping the lamp in paper or other material which would retain the heat, because it is possible to ignite easily combustible material in that manner. It is considered that a very serious fire once resulted from this cause.

In damp places the sockets should be rendered waterproof, and wherever there are inflammable vapors the lamps should be protected by glass receivers. When incandescent lamps are attached to gas fixtures, an insulating coupling should be inserted in the gas pipe.

In lighting vessels, when it is necessary to have lights near the compasses, the effect of the electric current on the compass should be carefully considered, and whenever an electric wire approaches within six feet of a compass, a wire of opposite polarity should be run parallel to it. I do not feel sure that this distance of six feet should be regarded as the minimum to which this rule should apply, and trust that the matter will receive careful investigation, on account of the importance of any question pertaining to the adjustment of compasses.

In the presence of inflammable vapors there should not be any hand switches; and as a general rule, wherever the conditions of illumination from a number of incandescent lamps are uniform, it is frequently desirable to use a main switch to throw them in or out, although the varying conditions of load or current on the dynamo are such that it is not recommended that over fifty lights should be so connected with any one switch unless the conditions of the case are thoroughly understood and agreed upon. All switches used in the conductors of electric lighting installations, apart from those at the lamps, should be double pole, and should be mounted on incombustible bases with an indicator showing whether the switch is open or shut.

Every electric lighting plant should be provided with instruments of precision for measuring the output of the dynamo. These instruments should be placed on the switchboard in a position where they will not be affected by magnetism from the dynamo.

The conditions of the operation of electric plants generally do not admit of the use of ordinary methods of measuring the resistance of the insulation between the earth and the system, and the magneto is used as a feasible method of indicating to some extent the presence of any ground of low resistance. Although this instrument has been severely criticised, yet it fills a useful purpose within the proper limits of its service. It is portable, can be used by any one, and the indications can be relied upon within the limits of the instrument. It is far more delicate than the galvonometer of 10 or 20 ohms resistance used in connection with two or three cells of a battery.

A magneto may not always be suited for use on extensive incandescent installations, because the static charge of the circuits is sometimes sufficient to ring the bell. A convenient method of indicating grounds of low resistance is by means of incandescent lamps placed on a conductor between the earth and the system, but such lamps should be connected with a spring switch in order that the ground may not be a permanent one.

The use of electric lighting and power apparatus is so firmly established as to render it undoubtedly one of the most permanent of appliances in use, and the time is past when temporary and makeshift methods can be tolerated.

There is a tendency towards the increased use of currents of higher electromotive force, wherever it is feasible to reach an economy of copper wire by such methods.

This tendency received a setback a few years ago by the failure of experiments attempted in France, involving the use of currents of electromotive force of six thousand volts. As late as three years ago, at a meeting of the National Electric Light Association, one of the members expressed the opinion that in the immediate future currents of as high as ten thousand volts electromotive force would be distributed. So deep was the feeling that the speaker was in error, indignation was expressed that such an opinion should be held by any one engaged in a discussion before that organization, and the president left the chair to engage in the debate and to place the seal of condemnation upon such radical ideas. It was only two years later that currents of ten thousand volts electromotive force were actually used in some cities.

The status of the uses of electricity for illumination and power is so well established upon a practical basis, as regards the service to be expected and the character of the attendance required, that there is but little of a tentative or experimental nature in such work, and there is therefore no excuse for the continuance of many of the temporary methods of installation which have been in such general use.

One of the pernicious results liable to occur as a consequence of such methods of installation is the depreciation of such apparatus—from which I apprehend that difficulties may arise in the future.

Because there is much that is strange, wonderful, and unprecedented in these applications of electricity, there has been a tendency on the part of the general public to expect too much from them, both by way of advantage and of mishap. In case of fire, the press frequently ascribe the results to electrical wires purely on presumption without any evidence to establish the fact. Furthermore, in many instances such allegations are made when the known facts or weight of presumptive evidence indicate a contrary cause. It has been fully established by the experience of the past twelve years that a well-installed electric lighting plant is the safest method of illumination.

Society and Club Notes.

OHIO TRAMWAY ASSOCIATION.

THE OHIO TRAMWAY ASSOCIATION held its annual meeting at Akron, O., on Nov. 11, and then enjoyed a banquet at the Hotel Buchtel. Thirty-five roads were represented by about fifty delegates. The officers of last year were re-elected as follows: John N. Stewart, of Cleveland, president; John Harris, of Cincinnati, vice-president; J. B. Hanna, of Cleveland, secretary and treasurer, and E. A. Stewart, chairman of the executive committee. A pleasant incident of the convention was the presentation of a handsome cane to J. A. Hanna, secretary and treasurer of the association, for efficient services rendered; and the gift of a like present to Vice-President John Harris, the oldest member of the association. The next annual convention will be held at Zanesville.

THE NEW YORK ELECTRICAL SOCIETY.

AT the invitation of Superintendent J. Elliot Smith, of the New York fire telegraph system, the society met at the Fire Headquarters, in East 67th street, on Thursday evening, Nov. 19. After a few introductory remarks, the president, Prof. Francis B. Crocker, introduced Mr. Smith, who outlined in brief the work accomplished by his department and then proceeded to explain the workings of the new apparatus with which the department has recently been equipped. Formerly the signals from the box were received at the central office and then transmitted to the fire companies by transmitters, which required the insertion of a toothed wheel corresponding to the box number from which the signal was sent. In order to gain time in the transmission of the box number, the following improvement was introduced. The signal box repeats its number five times. The first round is received at the central office only; but as soon as this is finished the attendant in charge throws a switch so that the remaining four rounds are relayed directly into the circuits connected to the fire houses; in this manner saving the time required to select and insert the numbered wheel in the automatic repeater formerly in use. In order to insure absolute accuracy, however, the signals are again transmitted in two rounds by the old repeaters.

After explaining the apparatus, Mr. Smith gave a demonstration of the speed at which the men answer the calls, and for that purpose pulled a signal box at a distance of about 1,000 feet from headquarters, where a fire company is situated. The company was on the ground and the hose connected 70 seconds from the time the alarm was sent in. Another interesting feature of the evening was an exhibition by the life saving corps, who manœuvred an extension ladder and showed how it could be readily applied to the rescue of persons imprisoned in the upper stories of burning buildings. The evening was one of the most pleasant which has yet been arranged by the secretary, Mr. Geo. H. Guy, whose intelligent work is bringing constant accessions to the ranks of the society.

PITTSBURGH ELECTRIC CLUB.

THE Electric Club met last week at the office of the Ft. Wayne Electric Company, on Wood street, president Morris Mead presiding. The constitution reported by the committee appointed to frame it was adopted. It was also reported that a suitable clubhouse on Penn avenue could be secured, and a committee was appointed to secure a lease of the property and also to furnish it. The building is a commodious one and will be adapted to social enjoyment. There will also be a large assembly-room, where lectures on scientific subjects will be given.

There are fifty applications for membership pending, and the club, now that the constitution has been agreed on, is expected to advance rapidly.

Reports of Companies.

THE WEST END COMPANY'S ANNUAL MEETING.

THE WEST END STREET RAILWAY COMPANY, of Boston, held its annual meeting Thursday, November 12. The principal business transacted was the election of 15 directors and the presentation of the annual report.

President Henry M. Whitney reiterated his belief in the advantage of electricity as a motive power, and stated that the sum paid out on account of accidents last year was smaller than the amount the year before, the claims for September, 1890, being 61, while for the same month this year there were but 44. He believed from what he had seen that the number of accidents by the electric cars will be proportionately less than by the horse cars. He advised increasing the capital stock and paying off the floating debts, of which nothing now remains but some long-time notes held by the savings banks, amounting to about $1,000,000.

The company introduced a large number of long cars during the year, and is now thoroughly convinced that the cost of running them is about the same as that for the short cars, while the increased earning capacity, as well as the increased accommodation to the public, is considerably greater. The increase in the earnings during the past year has been mainly in the places where the electric system is in operation. The company intends to change its entire system to electric traction as rapidly as possible. By the 1st of January 175 more long cars which have been ordered are expected to be added to the electric system.

During the past year the cars of the company have made 2,328,274 round trips, covering 17,462,572 miles, and carrying 119,264,401 passengers. The passenger receipts were $5,889,179.98, making the average receipt per passenger 4.94 cents.

The directors elected were: G. T. W. Braman, Isaac T. Barr, T. Jefferson Coolidge, Joseph S. Fay, Jr., Eustace C. Fitz, Henry B. Hyde, Walter Hunnewell, E. D. Jordan, Samuel Little, William Powell Mason, Theophilus Parsons, Dexter N. Richards, Nathaniel Thayer, Walter S. Swan, Henry M. Whitney.

Letters to the Editor.

ERRORS IN URQUHART'S "DYNAMO CONSTRUCTION."

DOUBTLESS Urquhart's "Dynamo Construction" will be extensively used by that large class interested in electrical work and not prepared to make their own methods of designing. Chap. XII. furnishes the first readily accessible, concise, practical guide for those who desire not simply to build a dynamo from specific directions, but to design a dynamo for any required use. It is unfortunate that there are several errors in this chapter. The following eight or ten corrections may be valuable to some who wish to make practical use of the matter:

(1) Near the bottom of page 192, R_m is here, and on page 193, the electrical resistance of the series field coil; and not the reluctance of the magnetic circuit, as on pages 190, 191.

(2) Page 193, $(R_s \times R_m)$ should be $(R_s + R_m)$.

(3) Page 193, $= 330\ P_w :: 100 : X_s$ should be

$$\therefore 7100\ P_w : 330\ P_w :: 100 : X_s$$

(4) and (5), page 194, 10^6 should be 10^{-6}, in two places.

(6) Page 194, 106 should be 10^{-6}.

(7) Page 194, 50 should be 500.

(8) Page 199, $C_s = 1.3$ ampere should be above the equation that precedes it.

I. THORNTON OSMOND.

Pennsylvania State College, Nov. 13, 1891.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED NOVEMBER 10, 1891.

Accumulators:—

Secondary Battery, N. H. Edgerton, 462,698. Filed Jan. 14, 1891.
A containing cell or jar, filled with an electrolytic fluid, contains a battery of electrodes arranged in sets of three each: each electrode is contained within and insulated from a metallic cell filled with active material; the central electrode in each set is of different polarity from the other two.

Alarms and Signals:—

Police Signal Telegraph System, C. A. Rolfe, 462,741. Filed Mar. 9, 1891.

Call-Box, E. R. Wilder, 462,785. Filed Dec. 17, 1890.
For district telegraph service.

Fire-Alarm Box, E. R. Wilder, 462,786. Filed Jan. 2, 1891.
A non-interference box.

Police-Signal System, N. B. Cregier, 462,808. Filed Nov. 26, 1889.
Adapted for the transmission of two or more signals simultaneously from different boxes to the central station.

Signaling Device for Elevators, C. G. Armstrong, 462,834. Filed Jan. 17, 1891.

Electrical Indicator for Elevators, C. G. Armstrong, 462,835. Filed Mar. 10, 1891.

Electrical Annunciator, J. B. Smith, 463,001. Filed Aug. 21, 1889.

Conductors, Conduits and Insulators:—

Electric Conductor, J. A. Barrett, 462,681. Filed Jan. 8, 1891.
The conductor is covered with a fibrous or meshed air-containing serving which is surrounded by a sized envelope, which in turn is covered with a sealing material. The sizing consists of either a mucilagenous, gelatinous or albuminous compound.

Electric Conductor, C. T. Snedekor, 463,079. Filed May 8, 1891.
Has a rubber covering, an adhesive substance upon the rubber covering, a powdered refractory material over the adhesive substance and a tape saturated with a silicate, and a suitable finish over the tape.

Electric Conductor, F. E. Degenhardt, 463,107. Filed Sept. 1, 1890.
Conducting wire is constructed with a strip having alternate elevations and depressions surrounding the wire and forming receptacles for the retention of air or gas.

Dynamos and Motors:—

Commutator, S. H. Short, 462,880. Filed May 26, 1891.

Armature for Dynamo Electric Generators, S. H. Short, 462,881. Filed June 12, 1891.
Consists of a laminated core of ribbon wound upon itself, bobbins wound around the core, and blocks of non-magnetic material secured between the bobbins and forming open-air spaces between the blocks, and also ensuring open-air spaces between the sides of the bobbins.

Armature for Dynamo Electric Machines, S. H. Short, 462,882. Filed June 19, 1891.
Comprises a laminated core slotted at its opposite edges, forming teeth, bobbins wound between the teeth, and flat magnetic rings secured to the sides of the armature outside of the bobbins.

Brush Holder for Dynamo Electric Machines, S. H. Short, 462,883. Filed July 6, 1891.

Brush Holder for Dynamo Electric Machines, E. Thomson, 462,973. Filed Feb. 20, 1891.

Steam Dynamo Electric Machine, F. M. Garland, 463,121. Filed. Feb. 4, 1891.
A design and construction adapted for mounting an engine and direct-driven dynamo upon the same base.

Lamps and Appurtenances:—

Electric Arc Lamp, J. E. Giles, 462,698. Filed Jan. 29, 1891.
Relates to an arc lamp cut-out.

Carbon Holder for Arc Lamps, J. J. Wood, 462,756. Filed Dec. 10, 1890.

Electric Arc Lamp, J. E. Gaston, 463,065. Filed Jan. 15, 1891.
Adapted to a head-light for locomotives.

Medical and Surgical:—

Electric Belt, P. E. Petterson, 462,732. Filed Mar. 11, 1891.

Miscellaneous:—

Phonograph, W. Bruening, 462,687. Filed Jan. 14, 1891.

Process of Purifying Tannin Solutions by Electrolysis, A. Foelsing, 462,694. Filed Apr. 23, 1891.

Telegraph Table, K. V. Miller, 462,720. Filed Sept. 23, 1890.
For support of telegraph instruments; an operating table.

Method of Producing Rainfall, L. Gathmann, 462,795. Filed July 16, 1891.
Inventor contemplates employing an electric circuit to fire off his balloons.

Mechanical Cut-Out, H. W. Burnet, 462,836. Filed Apr. 7, 1891.

Electric Safety Cut-Out Device, A. G. Waterhouse, 463,086. Filed June 24, 1891.

Railways and Appliances:—

Electric Railway System, H. C. Camp, 462,688. Filed June 30, 1890.
A conduit system. Relates to the construction of the conduit and of contact devices.

Device for Removing Ice from Overhead Wires, G. Hipwood, 462,707. Filed Aug. 24, 1891.

Electric Railway Motor, C. J. Van Depoele, 462,761. Filed Dec. 20, 1890.
Combines with the driving axle and wheels an armature fixed upon and carried by the axle, a circular field-magnet surrounding the armature and also carried by the axle and journaled thereon; has means, carried by the armature, for shifting the polarity of the field.

Electric Car Brake, J. D. Collier and J. K. P. Miller, 462,793. Filed Feb. 4, 1891.
Relates especially to methods of connecting electrical conductors between cars.

Electrical Connection and Signal for Railway Cars, J. D. Collier and J. K. P. Miller, 462,794. Filed Mar. 25, 1891.

Electric Car Coupling, J. D. Collier and J. K. P. Miller, 462,807. Filed Feb. 18, 1891.

Life Guard for Railway Motors, H. E. Harris, 462,814. Filed June 27, 1891.

Electric Circuit Closing and Breaking Device for Railway Tracks, T. H. Patenall, 462,850. Filed Feb. 20, 1891.

Heating and Lighting System, R. M. Hunter, 462,926. Filed Jan. 12, 1887.
Relates to heating and lighting railway cars.

Electric Railway System, G. T. Woods, 463,020. Filed Aug. 31, 1891.
Relates to distribution, and comprises a group of electromagnetically controlled contacts outside of the road-bed and accessible, each contact being electrically connected with one exposed terminal head in the road-bed.

Reversible Electric Trolley, J. W. Bates and C. E. Blake, 463,024. Filed Dec. 22, 1890.

Station Indicator, J. M. Nelson, 463,072. Filed May 14, 1891.

Telegraphs:—

Duplex and Quadruplex Telegraphy, F. W. Jones, 462,901. Filed Nov. 11, 1885.
Claim 1 follows:
In a duplex or quadruplex telegraph apparatus, the combination, with the device for preventing mutilation of signals received on the neutral relay at the instant of reversal, of an induction apparatus whose secondary is connected with such devices, while its primary consists of two coils, one in the main and the other in the artificial line.

Telephones and Apparatus:—

Signal Device for Telephone Pay Stations, W. Gray, 462,813. Filed Dec. 15, 1890.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED NOV. 17, 1891.

Alarms and Signals:—

Thermo Circuit Closer for Electric Fire-Alarms, J. Wrigley and G. P. Chambers, 463,298. Filed June 26, 1891.

Fire-Alarm Telegraph Repeater, G. M. Stevens, 463,340. Filed April 30, 1891.

Base Ball Indicator, J. L. Cutler, 463,491. Filed Feb. 24, 1891.

Fire-Alarm, A. Bichet and R. W. Whitney, 463,570. Filed Feb. 19, 1891.
Employs the action of water upon a turbine wheel for actuating the alarm.

Automatic Fire-Alarm System, G. W. Brown, 463,608. Filed Aug. 21, 1891.
Designed to prevent the sounding of false alarms.

Conductors, Conduits and Insulators:—

Insulator Support, T. C. Smith, 463,172. Filed Feb. 12, 1890.

Electrical Conduit, J. C. Love, 463,197. Filed Feb. 10, 1891.
Relates to the construction of the conduit and the support of conductors therein.

Machine for Covering Wire, M. D. Liddell, 463,389. Filed Nov. 3, 1890.

Coupling for Electric Wires, F. X. Gartland, 463,420. Filed July 16, 1891.

Electrical Conductor, P. H. Holmes, 463,512. Filed June 2, 1891.
A material adapted for use as a pencil for arc lights, commutator brushes, etc. Composed of plumbago united by a drying oil as a binder.

Insulator Bracket, V. A. Thomas, 463,587. Filed May 21, 1891.

Insulator Bracket, V. A. Thomas, 463,588. Filed May 21, 1891.

Dynamos and Motors:—

Armatures for Dynamos or Electric Motors, B. D. Southard, 463,174. Filed March 2, 1891.
A ring armature. Has a series of separable longitudinal sections, a series of coils wound upon such sections and wound parallel to the axis; has portions rigid with the sections projecting outside of the coils and adapted to maintain them in place against centrifugal force.

Electromagnetic Switch, C. H. Herrick, 463,192. Filed Oct. 20, 1890.
Adapted especially for use with shunt-wound motors. Operates to break the continuity of the circuit whenever the current is accidentally interrupted, and thus prevents a sudden inrush of current to the motor when the interruption has ceased.

Dynamo Electric Machine, M. C. Bert, 463,242. Filed Jan. 21, 1891.
Relates to the design and construction of the frame, and also to devices for cooling the armature.

Alternating or Pulsating Current Motor, L. Gutmann, 463,314. Filed April 7, 1890.
Adapted for working from a single exciting source. In addition to the usual field magnet coils, has a secondary set of field-magnet coils placed at an angle to the former and an armature enclosed by both sets of field coils and provided with one or more closed windings, each containing an odd number of closed circuits.

Electric Blower or Fan, W. B. Snow, 463,585. Filed April 7, 1891.

Circuit and Switch for Electric Motors, W. Lahmeyer, 463,605. Filed March 26, 1891.
Has a secondary armature on the same shaft with the main armature and means for switching the driving current through both the armature coils and the field coil, and to switch the driving current through the main armature coils and the current from the secondary armature coils through the coils of the field magnet.

Galvanic and Thermo-Electric Batteries:—

Galvanic Battery, W. A. Crowdus, 463,247. Filed Nov. 21, 1890.
An overflow receptacle is provided to receive the excess of liquid as it increases in volume.

Galvanic Battery, W. A. Crowdus, 463,248. Filed Jan. 24, 1891.
Relates to the construction of the porous cell and to the destruction of the fumes given off by a battery.

Lamps and Appurtenances:—

Electric Arc Lamp, W. Jandus, 463,154. Filed Dec. 4, 1886.
Intended to retard the waste or consumption of the electrodes.
Claim 1 follows:
In an arc lamp, an arc-inclosing chamber hermetically closed at all points excepting at its lower end.

Cut-Out, H. Lemp, 463,218. Filed June 21, 1887.

Mast Arm for Electric Lights, V. A. Thomas, 463,586. Filed Oct. 6, 1890.

Duplex Arc Lamp, E. P. Clark, 463,595. Filed Feb. 16, 1891.
Claim 3 follows:
In an electric arc lamp having a plurality of pairs of carbons and separate regulating mechanism therefor, an automatic switch for controlling the circuits, and an independent electromagnet located in the circuit of one pair of carbons and having its armature connected with the switch.

Measurement:—

Apparatus for Measuring and Recording Electric Currents, W. Thomson, 463,558. Filed Feb. 18, 1891.
An electromagnetic meter employing a recorder actuated by clockwork or by an electric motor.

Metallurgical:—

Ore Separator, W. D. Hoffman, 463,305. Filed July 15, 1891.

Metal Working:

Process of Welding Metals Electrically, C. L. Coffin, 463,486. Filed June 9, 1890.
Consists in first separately subjecting the articles to be welded to the action of a heating current and the voltaic arc, then pressing the articles together to form the weld.

Electric Welding or Working of Metals, C. L. Coffin, 463,487. Filed Mar. 4, 1891.
Similar to the next above.

Miscellaneous:—

Electric Lock, W. J. O. Johnson, 462,155. Filed Feb. 25, 1891.

Shoe Blacking Machine, F. G. Norton, 463,164. Filed May 5, 1890.

Electric Stop Mechanism, L. Mellett, 463,198. Filed March 21, 1890.
For instantaneously cutting off the steam from an engine.

Electric Lock, F. H. Starrett, 463,297. Filed Nov. 3, 1890.

Electric Switch, E. J. Bagnall, 463,311. Filed Aug. 3, 1891.
Adapted for use on high-potential circuits. Includes a safety fuse.

Electric Cigar-Lighting Apparatus, W. W. Foster, 463,384. Filed Aug. 14, 1881.

Electrical Switch, A. Swan, 463,396. Filed May 7, 1891.
A quick-acting switch.

Railways and Appliances:—

Ice Breaker and Electric Current Trnnsmitter, O. Smith, 463,257. Filed Jan. 31, 1891.
For clearing ice, snow, etc., from electric railway tracks and for making electrical contact with the rails.

Crossing for Electric Railway Conductors, W. J. Silver, 463,310. Filed Feb. 12, 1891.

Power Storing Mechanism for Electric Locomotives, J. A. Hockett, 463,315. Filed Oct. 22, 1890.
A clutch-and-spring device adapted to graduate the power of the motor when applied to the wheels.

Electric Locomotive, S. H. Short, 463,356. Filed April 8, 1891.
Employs beveled gears and flexible connections between each end of the motor shaft and the shaft of the beveled gearing.

Motor Cars for Electric Railways, T. E. Adams, 463,359. Filed May 28, 1890.
Consists of glazed sight openings or windows, enabling the driver of the car to keep the trolly line in view for some distance ahead.

Electrical Train Signal, J. B. Strauss, 463,395. Filed July 20, 1891.

Telegraphs:

Telegraph Sounder, J. Maret, 463,428. Filed Feb, 3, 1891.

Telephones and Apparatus:

Telephony, J. W. Gibboney, 462,188. Filed July 28, 1891.
Claim 1 follows:
The method of telephoning, consisting in making a record of the sound waves, causing such record to produce slower electric waves, impulses, or undulations of current of corresponding shape or character, transmitting such slow electric waves or undulations of current over an electric circuit, and recording such waves at the receiving end of the circuit.

Telephonic Relay, E. E. Weaver, 463,207. Filed Feb. 18, 1891.

Multiple Telephone Switchboard, F. A. Pickernell, 463,544. Filed Aug. 17, 1891.
Improvements in the class of multiple switchboards having normally discontinuous branches.

Multiple Switchboard, F. A. Pickernell, 463,545. Filed Aug. 17, 1891.
Further improvements as next above.

Speaking Tube Attachment for Telephones, L. H. Snyder, 463,556. Filed Jan. 28, 1891.

Combined Telegraph and Telephone, E. Berliner, 463,569. Filed June 4, 1877.
For part of the specification and the claims in full see Supplement with THE ELECTRICAL ENGINEER of Nov. 18, No. 185.

THE LIGHTING OF THE WORLD'S FAIR.

EVERY Exposition building in Jackson Park is to be supplied with complete electric light service during the period of the World's Fair. Plans have already been completed for lighting nine of the great buildings, and thus far the scheme contemplates the employment for those buildings of 5,180 arc lamps of 2,000 candle power each, and 14,700 incandescent lamps of 16 candle power each. The following arrangement of lamps had been agreed upon by the Committee on Electricity, the Committee on Grounds and Buildings, and the Chief of Construction: Arc lights—Machinery Hall, 600: Agricultural, 600; Electricity Building, 400; Mines and Mining Building, 400; Transportation Building, 450; Horticultural Hall, 400; Forestry Building, 150; Manufactures Building, 2,000.

The Fine Arts Building will be completely lined with incandescent lamps, and it is estimated that one mile of wall space, on which pictures may be hung, will have to be lighted. The number of lamps agreed upon is 12,000. There are to be no arc lights in this building.

The Woman's Building is to be lighted by both systems. It has been decided to place in it 180 arc lights and 2,700 incandescent lamps. The reception and dressing-rooms will be furnished with the incandescent lamps.

The Administration Building will also be supplied with incandescent lamps. The exact number has not been agreed upon, but an approximate estimate is 10,000.

THE CENTRAL AND SOUTH AMERICAN TELEGRAPH COMPANY.

THE Central and South American Telegraph Company has purchased the Transandine Telegraph Company, having a mileage of 1,200, and connecting Valparaiso with Buenos Ayres. The purchase price is $587,000, and to raise this the capital stock of the Central and South American Company is increased from $6,000,000 to $6,500,000, the balance of purchase price to be paid from the surplus of the company.

The Transandine lines were built in 1872, and the annual reports for the past ten years show its net earnings have amounted to $1,582,682.48 currency, and its dividends to $1,176,000 currency being an average of nearly 17 per cent. on a capital of $700,000 Chilian currency.

The gross traffic of all lines south of Galveston, derived from the east coast of South America by means of the Transandine Telegraph Company, for the three years, 1888, 1889 and 1890, was $885,000 gold. During those years the Central and South American Company divided this traffic with the West Coast Telegraph Company, but now that the former and the Mexican Telegraph Company will own the whole line between Galveston, Tex., and Buenos Ayres, Argentina, it will be in a position through its ownership of this important link to improve its service and thereby command a profitable share of the east coast traffic. Notwithstanding the financial depression in Argentina and recent war in Chili, the present receipts of the company are highly satisfactory, and if maintained will provide the usual dividend on $6,500,000 and yet leave a surplus estimated at over $225,000.

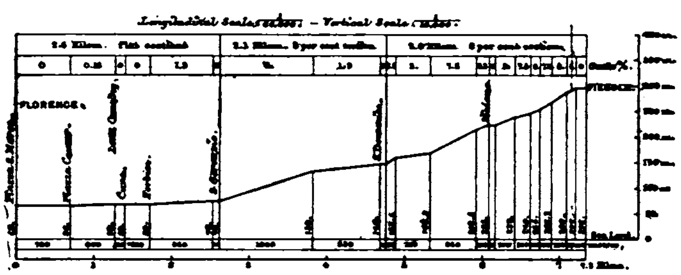
TELEGRAPHERS' MUTUAL BENEFIT ASSOCIATION.

A VERY encouraging report was read by President Merrihew at the 24th annual meeting of this association. It showed that 37 deaths were reported during the year, and a net gain in membership of 147, bringing the total membership to 3,628. The treasurer's report showed the amount received from assessments and fees during the year, $39,445.50, (there were but 11 assessments). The interest from the reserve fund and current deposits during the year amounted to $6,314.28. The sum of $7,373.65 was added to the reserve fund during the year, raising the reserve fund to a total cost value of $107,557.06. It was a very enthusiastic meeting. Steps were taken to insure a proper celebration of the twenty-fifth anniversary, which will take place November, 1892. The president was authorized to appoint a committee of fifteen whose mission it will be to awake enthusiasm throughout the country and incidentally arrange the plans for the next meeting. In this the association expects the co-operation of the telegraph and electrical press.

All the old officers were re-elected, and the meeting was followed by a most enjoyable dinner of the Magnetic Club.

A DESCRIPTION OF THE FLORENCE-FIESOLE RAILWAY.

FIESOLE is situated 800 feet above the town of Florence, of which it is a suburb. The large residential and tourist traffic between the two places has, within the last few years, led to several proposals for carrying a railway up the steep slope to the centre of Fiesole at the summit of the hill. But there were difficulties in the way, for the authorities resolutely set their faces against the employment of steam, and owing to the peculiar nature of the place cables were impracticable. It was not until 1889 that the problem appeared to be solved, and it was then resolved to build an electric railway. The line, which measures 4½ miles between the terminal points, has gradients up to 8 per cent. It is the first continuous steep-grade railway in Europe. The system employed is an improved form of Sprague. The line was constructed and worked by the Chianti and Florentine Hills Railway Co. It was open for traffic under a provisional order in September, 1890, but in consequence of the accident which occurred on the 29th of that month, and by which five passengers were killed, the service on the steep-grade section was, by order of the government authorities, suspended pending an inquiry. This inquiry having conclusively shown that the accident was in no way due to any defect in the permanent way, electric plant, rolling stock or brake power, but solely to the negligence of the brakeman, the line was reopened throughont in the month of April, 1891, and has ever since worked with perfect safety and regularity. The line is laid throughout with steel rails of special Vignoles section, weighing 48 pounds per yard. The cost of the permanent way does not exceed $8.25 per lineal yard. Of the total length of the line, 4½ miles, no less than 52 per cent. is in curves, the sharpest of which chiefly occur on the steep-grade section. The guard rails are used only on curves sharper than 262 feet radius. The electric works are situated at S. Gervaise, 1½ miles from the Florence terminus and three miles from that at Fiesole. Three return flue boilers, supplied by Messrs. Tosi, of Legnano, near Milan, of 80 h. p. each, feed three compound en-



PROFILE OF FLORENCE-FIESOLE RAILWAY.

gines with vertical cylinders working at 225 revolutions per minute; these drive three No. 20 Edison compound dynamos, which at 900 revolutions give 110 amperes at 500 volts each, the dynamos developing 75 effective h. p., or 93 per cent. of the engine power. One dynamo is sufficient for the ordinary winter service as well as for lighting the cars and the works; while on feast days and holidays and in the summer season, when the service is increased, the requisite power is supplied by two dynamos, one engine and one dynamo being always kept in reserve. The circuit is arranged as follows:

An overhead main conductor, consisting of a covered copper wire, is carried on poles placed at a distance of from 6½ to 13 feet from the centre of the line, and 130 feet apart on straight sections, and 80 feet on curves. The contact wire, which is of silicon bronze of one-fifth of an inch in diameter, is suspended over the centre of the line from the brackets fixed on iron poles. The main conductor, which has a resistance of 0.8 ohm per kilometre, transmits the current to the contact wire in sections of about 130 feet, there being, moreover, between S. Gervaise and Fiesole two subsidiary conductors which are connected with the main conductor. No earth plates are used, but the rails are connected by a copper wire fixed to small iron pins. The car seats 24 passengers, and including platform is 20 feet in length. Curves of 45 and even 36 feet radius can be passed with perfect safety, as the width of the wheels, including the flange, and that of the rail-head is 2 inches, while the space between the rail and the guard rail in sharp curves is widened to 2.2 inches. Each car is lighted by 5 incandescent lamps. Each platform is fitted with a regulator disc, a valve handle, a mechanical chain brake, and an electric safety brake, all four being within easy reach of the driver, while the guard on the back platform has to watch the trolley. The whole of the electric plant including car frames and motors was supplied by the Edison General Electric Co., of New York, and mounted by Mr. Sprague's agent. The brakes are possessed of singular power, are quite independent of each other, and can stop the car at top speed in an incredibly short length. Mr. Scheibner, commenting upon the recent accident, gave the following explanation: The accident occurred about 875 yards from the summit. It appears that the driver started with an over-loaded car and at an excessive initial speed, and after having applied the hand brake, he tried in addition to reverse the motors, but instead of doing so put the current on again, thereby accelerating the motion of the car, which, on passing through a polycentric curve of 120, 45 and 60 feet radius on an intermediate incline of 3 per cent., was thrown off the rails against a parapet. The car having covered the distance of 2,400 feet in a little over a minute must have acquired a speed of 30 miles an hour, so that the centrifugal force in the 45-foot curve was equal to 8.32 tons, which, being in excess of the weight of the car, accounts for its being thrown off the point. This sharp curve, which has since been widened, probably averted a greater disaster which might have happened if the car had continued its downward course. The rigidity and solidity of both the rolling stock and permanent way are attested by the fact that, while the superstructure of the car was broken, the frame and motors sustained only trifling damage, and the permanent way was found in perfect condition. The total cost of the line was $120,000, or nearly $30,700 per mile. The working of the line is estimated to cost a little over 14 cents per car mile, but it is said that the cost will be decreased when a proposed extension is carried out. The number of passengers carried per day averages 600 and 2,500 on feast days. The fares charged are about 3 cents per mile. There seems to be no doubt that for a steep grade line, such as the Florence line with a 10 or 20 minute passenger service, electric motive power offers advantages far superior to those of any other system of traction. Considering the ease and elastic motion of the car, its adaptibility to sharp curves, the ease with which it can be run in either direction without being turned and with a total absence of smoke, etc., it may be safely averred that electric traction on the Florence line has been brought to a high state of perfection. I am informed that various economies are being introduced into the working, and the accounts which are to be shortly published will show satisfactory results.

H. S.

GERMAN GAS AND ELECTRIC LIGHT STATISTICS.[1]

BY CLARENCE FELDMANN.

UNDER the title of "How Shall We Build Our Central Stations?" Herr Friedrich Ross, director of the Helios Company of Ehrenfeld, has published a pamphlet written especially for municipal authorities. The author states in the preface that he is a partisan of the alternate-current transformer system, and then gives some details of a few German central stations working with accumulators, from which we extract the following: The central station of Barmen delivered to the mains from the 1st of May, 1890, till the 10th of the same month 1,771,653 watt-hours, the total output of the dynamos being 2,681,970 watt-hours. The charge of the accumulators was 1,759,731 watt-hours, and their discharge 547,356, giving a mean efficiency of 37 per cent. Shortly afterwards the battery had to be reconstructed on account of buckling of the plates. From the 20th to the 28th of September, 1890, the efficiency amounted to 55.8 per cent., the total output of the dynamos being 3,769 kilowatt-hours, and the consumption in the net-work 2,985 kilowatt-hours, the accumulator charge 1,784 kilowatt-hours, and the discharge 996.5 kilowatt hours. Similarly the mean efficiency of the central station of Darmstadt was 38.6 per cent. in 1889, and 55.9 per cent. in 1890, after the accumulators had been reconstructed towards the end of August, 1889.

All central stations working with accumulators have been planned on the assumption of a rather low number of hours of daily maximum consumption; and the author asserts that such statements are erroneous, or are so in most cases. He shows from the gasworks statistics of 24 of the largest German gasworks that the gas supply for heating and power purposes amounts to only 6½ per cent. of the total output, and that for 16 other gasworks the hours of heavy consumption were, on an average, 8.7. Another table contains the maximum consumption in one day, and in one hour of this day, for several electric stations, and shows the quotient of these two quantities, which gives the hours of maximum load: Berlin, 8.8; Barmen, 6.9; Elberfeld, 5.6; Hamburg, 8.2.

Some interesting details of the Düesseldorf central station are then given. It is stated, among other things, that in Darmstadt the total length of gas main is about 116 kilometres for, approximately, 35,000 gas lights, or 3.3 metres of main per gas burner, corresponding to one 16 candle-power lamp. The electric network is planned with about 32 kilometres of mains for about 20,000 16 candle-power lamps, or with 1.6 metres of mains per lamp. For the central stations at Darmstadt and Elberfeld, Herr Ross gives the cost of current production per 16 candle-power lamp-hour as 2.45 and 1.33 pfennigs (one pfennig = .12d.), respectively, the annual cost per lamp being 3.55 marks in Darmstadt and 4.8 marks in Elberfeld. For these two stations the maximum consumption is nearly equal, but the average annual number of lamp-hours is 289 in Darmstadt and 730 in Elberfeld.

In the last table are given some average values for the annual lamp-hours, the length of main per light, and the ratio of daily maxima to total lamps installed, all calculated from the statistics of 35 gasworks of various sizes; these three numbers varying from 1,610 to 1,270 hours; 2.49 to 4.4 metres, and 50 to 57 per cent.

1. London *Electrician*.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

When you have engaged advertising space, help the paper make it pay you by putting in some effective "ads."

THE WIRT DYNAMO BRUSH.

THE Wirt dynamo brush was designed with the intention of combining the good qualities of carbon and copper brushes, and it is claimed that by its use sparking, with its attendant wear and damage to the commutator, has been almost entirely eliminated. The principle involves the use of a lamination of perfect and imperfect conducting materials, the good conductor being placed between two layers of higher resistance. The result is that the main current is carried away principally by the middle portion with a minimum of heat, while the wasteful currents are partly prevented and in part "wire drawn" to the point where the energy is too small to do mischief. The construction of the brush gives a cushion touch on the commutator, permitting the use of a very light tension.

The resistance metal in these brushes is new and has a resistance about fifty times that of copper, or three times the resistance of German silver. It is used in sheets as thin as letter paper, with the result of great flexibility and smooth running, and as the contact on each successive commutator bar is made first with this high-resistance metal, and broken also on the high-resistance metal, the destructive short-circuiting currents which cause sparking are almost entirely prevented. At the same time there is sufficient pure copper in the middle of the brush to carry the main current to the brush holder without undue heating.

A number of letters from engineers who have used these brushes speak highly of their merits. They are manufactured by the Electrical Supply Co., of Chicago.

BURTON HEATERS.

F. D. CASSANAVE, E. C. Bradley, M. C. Bristol, W. M. Grafton, L. L. Summers, and C. H. Summers, all officials of the Pennsylvania Railroad and Western Union Telegraph Company have visited Chicago for the purpose of arranging with the Burton Electric Company to put on the Pennsylvania limited Chicago and New York trains the Burton electric heater.

The Electric Merchandise Company received, a few days since, the following dispatch, the latter part of it referring to a duplicate order for four additional sets just ordered by mail:

"OTTUMWA, IOWA, Nov. 14, 1891.

"Heaters working satisfactorily. Hurry the others along as soon as possible.

"OTTUMWA ELECTRIC RAILWAY."

CROWN ELECTRIC MANUFACTURING COMPANY.

THE CROWN ELECTRIC MANUFACTURING COMPANY, of 99 Cannon street, Bridgeport, Conn., has recently been organized with the following named officers, gentlemen who are well known in electrical circles: President, F. H. Bryant; vice-president and general manager, E. L. Smith; secretary and treasurer, Chas. J. Norton; electrician, Geo. B. H. Foster. The Crown Electric Manufacturing Company will manufacture a full line of electrical supplies, including sockets, switches, ceiling cut-outs, etc., all of which specialties will be entirely new. The success in the past of the several gentlemen composing this company gives the new concern bright prospects.

A BIG ORDER FOR KERITE.

J. H. BUNNELL & Co., of 76 Cortlandt street, New York City, who have a large and growing trade in insulated wires and cables, have just taken an order for no less than 700,000 feet of Kerite wire for telegraphic work, to be used in this vicinity. Bunnell & Co. are also very busy on all their other lines of work, and find no cause for complaint as to the outlook.

THE TAPER-SLEEVE PULLEY WORKS.

THE new Taper-Sleeve friction clutch, illustrated on page 565 of our last number, we are requested to state was patented Sept. 10, 1889, and is controlled by the Taper-Sleeve Pulley Works, of Erie, Pa.

GREAT WESTERN ELECTRIC SUPPLY CO.

THE Great Western Electric Supply Co., sole agents of the Sun arc lamp, are receiving many orders for this specialty and the sale is increasing wonderfully. The Sun arc lamp is specially adapted for use in theatres, central stations, halls, stores, or in fact any place where the ordinary arc lamp is not desirable. It gives a steady, clear, bright, white light, and for direct current, incandescent circuits is strongly recommended.

The Great Western Electric Supply Co. are also agents for the celebrated K. K. wire, a large amount of which they sold last month, and the amount sold so far this month shows that they will have an even larger sale than ever.

The Great Western Electric Supply Co. are now preparing to manufacture their own fixtures. They are doing a very large business in this line, and will be able in the future to fill orders very promptly, and also set up any special designs that may be desired. Their new lighting catalogue is out and is complete in every detail. It is now ready for distribution.

THE NATIONAL ACOUSTIC TELEPHONE.

THE National Manufacturing Co. has recently installed several telephone lines for the Old Colony R. R. Co., which are giving good service. An important line connects the train despatcher with a signal station at the drawbridge. Another line is ordered for depot service, also one for use at freight station at Middleboro.

The Hotel Brunswick enjoys the use of this telephone on a line connecting the house and stables. The Oliver Ames and Sons Corporation also uses the service at their plant in North Easton. The outlook for the company is quite promising. Orders are being daily received from the West and South, to say nothing of the many cheap systems that give satisfactory service.

THE RIES ELECTRIC SPECIALTY CO.

THE Ries Electric Specialty Co. of Baltimore, Md., have just issued a very neat, pithy and interesting pamphlet, letter envelope size, on their specialties, and devoted chiefly to their well-known regulating sockets for alternating incandescent lamps. In the power to control the amount of current used and the quantity of light emitted, this socket has recommendations that cannot be neglected by a single station superintendent or consumer of current, and its universal adoption is simply a question of time. This little brochure points out its many merits, explains simply its operation, and quotes several complimentary opinions expressed about it.

WILMOT & HOBBS MANUFACTURING COMPANY.

THIS company has recently issued a little article combining the element of usefulness with that of ornament—something not always found in catalogues and the like. The article in question is a 12-inch ruler, which may also be used as a paper cutter.

The obverse of this ruler tells where Wilmot & Hobbs Manufacturing Company may be found for business purposes, and names in a modest way the goods handled by this company, and in addition gives the price of the ruler. The reverse shows a table of gauges, and gives a little law for determining the weight of sheet steel, brass and copper.

DETROIT ELECTRICAL WORKS.

THE Detroit Electrical Works have just closed a contract with the Kokomo City Electric Railway Co., of Kokomo, Md., for one 80,000 watt generator and five 30 h. p. Standard motor equipments. The whole outfit is to be delivered on the cars at Detroit for shipment East by December 15. The works are quite busy on a number of contracts, and expect to be very active all winter.

WHITMAN & WILKINSON.

THE above firm of patent solicitors and counselors in patent causes, of the Atlantic Building, Washington, D. C., have issued a sixth edition of their neat little pamphlet, "Notes on Patents." It contains in brief space a vast amount of useful information on the subject of patents, and contains a number of very warm testimonials from clients in various parts of the country.

WILLETTS POINT, L. I.—The iron roof for the storehouse which the U. S. Government is building at Willetts Point, L. I., will be furnished by the Berlin Iron Bridge Co., of East Berlin, Conn.

THE WAGNER-QUEEN PORTABLE VOLTMETER FOR ALTERNATING AND DIRECT CIRCUITS.

MESSRS. QUEEN & Co., of Philadelphia, are just putting upon the market a new voltmeter which is claimed to present many valuable features never before found in a single instrument. The voltmeter is the invention of Mr. Frank Wagner, for a number of years connected with the Thomson-Houston Electric Co., in charge of their Mexican business, and now on the mechanical engineering staff of the University of Michigan, at Ann Arbor. It is of the "hot-wire" type, depending, like the Cardew, on the expansion of a stretched wire which is heated by the passage of a current due to the E. M. F. being measured. This stretched wire is connected with a long and very light aluminum index in such a way that the amount of expansion is greatly magnified. The "hot-wire" is only about five inches long and has in series an extra resistance wound anti-inductively. By altering this extra resistance the instrument may be adjusted to different ranges. The stretched wire is exceedingly thin, and therefore immediately assumes the maximum temperature due to the E. M. F. being measured. The voltmeter is thus exceedingly dead-beat and readings may be taken very quickly.

The voltmeter is direct-reading for both alternating and direct circuits, the resistance being "non-inductive." Two ranges are offered with a maximum of 55 and 125 volts respectively; both ranges are graduated in single-volt divisions from 1.5, their maximum reading, these divisions being nearly equal and covering about $\frac{1}{12}$ inch each in the 55-volt instrument and about $\frac{1}{32}$ inch each in the 125-volt instrument. A mirror is inlaid in the scale so that parallax is avoided in taking readings.

Messrs. Queen & Co., as well as Mr. Wagner, have spent considerable time in developing and perfecting this voltmeter and believe that they have made it an instrument indispensable to every working electrician and electric light inspector in the country. The form, as now exploited, is intended only for general testing work, and is not a station instrument in any sense of the word. It is made almost entirely of aluminum, a metal which Messrs. Queen & Co. are now using extensively, and is believed to be the lightest voltmeter made. Complete and calibrated it weighs but 22 ounces. It is rectangular and smooth and can easily be slipped into a good-sized pocket. It measures, outside, 7¾ inches x 4 x 2

WAGNER-QUEEN PORTABLE VOLTMETER.

inches. The instrument has few parts and these are very strong; it is thus well adapted for transportation.

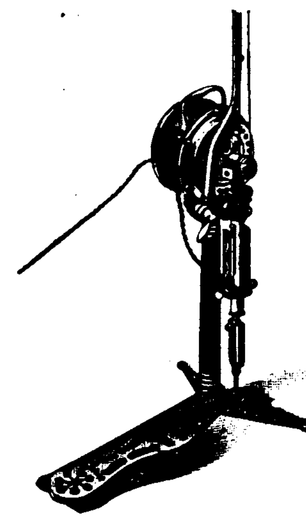
The outside case of the "Wagner-Queen" voltmeter is an emery-finished bronze, having a beveled glass over the scale. Each instrument is furnished in a neat carrying case with leather handle. An attractive descriptive circular, No. 265, has been issued by the makers.

PATENT OFFICE FACTS.

WE have received a pamphlet entitled "Information and Advice Relative to Patents," from C. A. Snow & Co., patent attorneys, of Washington, D. C. It contains directions for, and cost of, procuring patents in the United States and foreign countries; information about the registration of trade-marks, copyrights, caveats and designs; also abstracts of court decisions in patent cases, and much other matter of interest to inventors, patentees, manufacturers and others interested in patents. It will be mailed free to any one addressing C. A. Snow & Co., Washington, D. C.

THE EMERSON ALTERNATING CURRENT DENTAL ENGINE.

DURING the past summer the Emerson Electric Manufacturing Co., St. Louis, have perfected and successfully placed upon the market a very simple and quite efficient alternating-current motor of small size suitable for operating fans, sewing machines, jewelers lathes and dental apparatus. The illustration shows the motor attached to a dental engine. The operation is similar



EMERSON ALTERNATING CURRENT DENTAL ENGINE.

to that of their sewing machine motor attachment, that is, the speed of the motor is controlled by a foot treadle. The farther the treadle is pressed down the greater the speed of the motor. Any desired speed can be produced, the motor responding instantaneously to the movement of the foot treadle. A special form of regulator has been perfected for this purpose, giving the operator more thorough control of the speed.

The dental engine is of the usual standard form, containing both drill and automatic mallet attachments. By means of a handle attached to the top of the motor the entire machine can be lifted and moved at pleasure. The parts are so balanced that the machine retains its vertical position while being moved. The entire machine is substantially constructed and finely finished.

ELECTRIC MOTORS IN NEW YORK CITY.

THE Crocker-Wheeler Electric Motor Company are doing a very flourishing business. Among their recent installations may be mentioned the following in New York City: Three 5 h. p. and two ¼ h. p. motors for Mr. Louis Sherry, the well-known caterer, 37th street and 5th avenue; one 5 h. p. in the Marlborough Hotel, running ice cream freezers; and five ¼ h. p. to the well-known Otis Brothers Elevator Co., to run in connection with their new pump; four 3 h. p. motors, each driving a 48-inch fan, in the Stock Exchange; two 1 h. p. and several small outfits to the Madison Square Garden; one 1½ h. p. new style combination motor and organ attachment for Miss K. Drexel, 103 Madison Avenue, neatly encased in a black walnut cabinet, placed in the elegant music room at her residence; one 2 h. p. and several smaller sizes to Mr. F. S. Blackall, 239 Broadway; one each ½, ¼, and ⅛ h. p. fan outfits to the Irving Bank, corner of Warren and Greenwich streets; one 2 h. p., running printing press for the *Jewelers' Review*, 58 Maiden Lane. They have also furnished one 3 h. p. motor for Prof. Browning's Industrial Institute, West 55th street; two 1 h. p. motors in Dennett's restaurant, at 140 East 14th street; one 3 h. p., one 2 h. p. and two 1 h. p. at Dennett's new restaurant, 25 Park Row; also one 1 h. p. combination triplex pump with automatic tank switch, and a dumb waiter operated by 1 h. p. motor at same place.

THE KNAPP ELECTRICAL WORKS.

THE Knapp Electrical Works, Chicago, are selling quite a number of Bain compensating voltmeters and ammeters that they have just placed upon the market. These instruments are very accurate and do not get out of calibration.

This company are also agents for the Perkins Electric Lamp Co. and the Safety Insulated Wire and Cable Co., and report an excellent business in both of these branches.

NEW YORK NOTES.

THE JOHN E. BEGGS MACHINERY & SUPPLY CO.—We would call the attention of our readers to the advertisement of the John E. Beggs Machinery & Supply Co. The machinery listed will be found as Mr. Beggs represents it, and was taken from a central station near New York City. A considerable quantity has been sold, but there still remain some dynamos and electrical apparatus of the most modern type. It will be at once seen that the list presented would enable any contractor to put up at a reasonable figure a complete central station or isolated plant. Mr. John E. Beggs can be seen daily at his office, 74 Cortlandt street, New York City; and as the mentioned apparatus has been purchased outright by him, no delay will be encountered in delivery.

E. G. BERNARD & CO., of Troy, N. Y., have been awarded the contract for equipping the West Troy station with new machinery, etc., as their bid was the lowest available, and at the same time conformable to specifications. The equipment is to consist of a new and latest improved 50-light dynamo (Edison Gen. Elec. Co.) with automatic regulator, lightning arrester, and other safety apparatus, together with twelve new arc lamps of 2,000 candle power each, and the entire machinery to be set up in first-class order. Work is expected to begin in a few days.

THE W. S. HILL ELECTRIC CO., 54 Devonshire street, Boston, New York offices 136 Liberty street, have just issued a very neat and pretty supplementary catalogue devoted to the illustration and description of their excellent specialties, including motors and dynamos, cut-out switches, double-pole converter switches, transfer switches, station switches, fuse blocks, bus-bar connections, rheostats, arc lamps, etc. These specialties are the invention of Mr. W. S. Hill, the well-known electrician of the company.

BARTLETT & CO. now announce their removal to 21 and 23 Rose street, this city, where they have added extensive printing to their designing and engraving establishment. They are now equipped for executing every description of printing on their premises, and will be pleased to submit quotations for anything required in these lines.

THE CONNECTICUT ELECTRIC LIGHT ASSOCIATION met at New Haven last week, with Mr. J. E. English, president, in the chair. The usual business was transacted, including re-election of officers, etc. The proceedings wound up with a most enjoyable dinner.

ST. LOUIS NOTES.

THE EMERSON ELECTRIC MANUFACTURING CO., since their removal to their new quarters, are doing a large business in their various specialties. Their capital stock is to be increased from $50,000 to $75,000. They have just perfected and have ready for the market an improved dental engine motor for alternating currents. Before the close of the year they expect to get out a catalogue covering all their merchandise.

THE HEINE SAFETY BOILER CO. have made the following sales recently: 200 h. p. boiler to the Forest City Electric Light and Power Co., Rockford, Ill., and five 200 h. p. boilers to the Denver Consolidated Electric Light Co., Denver, Col. Among their orders outside of electrical interests is a notable one of 18 250 h. p. boilers for the Broadway and Seventh Avenue Cable Railway, New York.

W. L. ARNOLD, agent for the Thomson-Houston Electric Co., has made the following sales: 650-light alternating to Mascoutah, Ill.: 30-arc light to the Howard Allen Iron Co., Bessemer, Ala.; 100-light to the south side plant of the St. Louis Sanitary Co., and 300-light, alternating, to Morrellton, Ark.

THE INTERSTATE COMPLETE ELECTRIC CONSTRUCTION CO. have put in 160 Heisler lights additional at Kingman, Kan., and are now engaged in rebuilding the Heisler plant at Liberty, Clay Co., Mo. Fifteen Excelsior arc lights will be added to the plant.

WESTERN NOTES.

MR. W. T. RICHARDSON, formerly of the Southern Electric Company, of St. Louis, is now connected with the Central Electric Company. That company is now receiving a number of large orders for its Acme lead covering cable for underground work. This cable is giving especially good satisfaction, and possesses eminently the properties of durability, high insulation and conductivity, making it particularly adapted for underground work.

THE TRIUMPH COMPOUND ENGINE COMPANY, Cincinnati, O., report inquiries coming from all parts of the country for their various styles of engines, and thus far the fall trade has, beyond their most sanguine expectations, demonstrated the increasing popularity of their engines. They have lately been compelled to run overtime in order to meet the increasing demand.

THE BAIN ELECTRIC MFG. CO., 47-49 South Jefferson street, Chicago, among recent orders have received the following: Barnett & Record, Minneapolis, Minn., one dynamo, 12,000 watts, eight arc lamps, 150 incandescent lamps; Mosher Arc Lamp Co., one alternator and converter for arc lamps, one 3,000-watt constant potential dynamo, 110 volts; Indiana Novelty Mfg. Co., Plymouth, Ind., one 8,000-watt constant potential dynamo, 110 volts; Boyd-Conklin Electric Co., St. Louis, Mo., one 3,000-watt constant potential dynamo, 110 volts; Francis Dupont, Wilmington, Del., one 12,000-watt constant potential dynamo and extra armature, one 8,000-watt constant potential dynamo and extra armature; Chicago Paper Co., one 1½ h. p. motor, 220 volts.

MR. WM. HOOD, 239 La Salle street, agent for the "Jewel" incandescent lamps, is gathering around him considerable electrical talent. In addition to Mr. J. G. Nolen, who is now with him, Mr. W. F. Matterson, who has been his electrician for a long time past, is still with him and attending to various special work. Mr. Matterson is a young man, bright and energetic, and well versed in electrical science, and particularly so in the management of storage batteries, to which subject he has devoted a large amount of time and attention.

MR. J. G. NOLEN, a well-known expert electrician and one of the old timers in the business, having been associated with the Brush Co. in its early days and later with the Thomson-Houston Co., for both of which concerns he has installed a large number of plants, is now with Mr. Wm. Hood, of Chicago, looking after his incandescent and arc-lighting business.

LITTLE ROCK, ARK.—The City Electric Street Railway Co. have contracted with the Pond Engineering Company, of St. Louis, for three Hoppes live steam feed-water purifiers for immediate shipment. Each of these purifiers is to have a capacity sufficient to take care of the feed-water for 250 h. p. boilers.

CICERO, ILL.—Rapid progress is being made towards the enlargement of the plant of the Cicero and Proviso Street Railway Co. They have placed orders with the Chicago office of the Pond Engineering Company for an 800 h. p. Hoppes exhaust feed-water heater, and one 8-inch and one 6-inch Pond separators.

THE CHICAGO ELECTRIC MOTOR CO. are manufacturing and placing on the market a perfected oil paper for insulating purposes. This company is also doing a large amount of repair work, rewinding dynamos and motors, and have received quite a number of very flattering testimonials from their patrons.

MR. C. T. RUTTY, the general traveling representative of the McCreary Electrical Specialty Co., of New York, was in Chicago last week and found trade in his line of specialties first rate. Mr. Rutty is making an extended Western trip, looking after the requirements of his numerous customers.

THE ELECTRIC APPLIANCE CO. are rapidly getting their handsome new store, at 242 Madison street, into business shape and a stock of general electrical supplies of all kinds is being received. They have already booked some nice orders for "Paranite" wire, and they state that it sells at sight.

THE UNION ELECTRIC WORKS, Springer Building, Chicago, report the demand for their new annunciators as considerably in excess of their expectations, and they are working hard to keep pace with their orders.

Mr. H. H. Burke has been appointed superintendent of the Mt. Forrest Road Electric and Gas Co., of Mt. Forrest, Ia. Mr. Burke was in Chicago recently and left last week to assume his new duties.

HELLO "CENTRAL."—Attention is called to the special announcement of the Central Electric Co. in our advertising columns this week. Peruse their munificent offer and take advantage of it.

MR. H. A. STUCKY, of the National Electric Manufacturing Co., of Eau Claire, is at present in Chicago superintending some important installation work.

NEW ENGLAND NOTES.

MR. M. A. CARTER, who almost from the start has been superintendent and electrician of the Skowhegan Electric Light Co., has resigned to accept a more lucrative position as superintendent of the North Attleboro and West St. Railroad Co.

MR. H. S. QUINT of the Thomson-Houston Electric Light Company, of Lynn, Mass., has assumed the duties of superintendent of the electric light company at St. Albans, Vt.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE

Electrical Engineer.

A WEEKLY REVIEW OF THEORETICAL AND APPLIED ELECTRICITY.

(Copyright 1891, by The Electrical Engineer, 150 Broadway, New York.)

Vol. XII. No. 187. NEW YORK, DECEMBER 2, 1891. Price 10 Cents.

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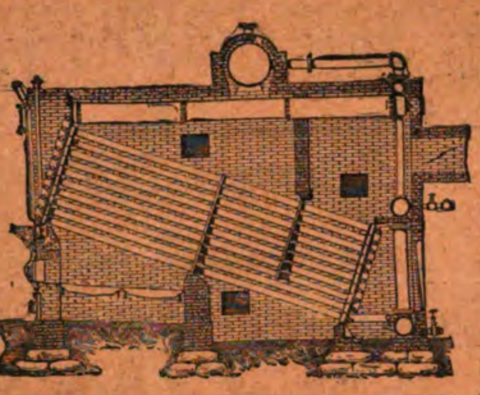
Root's Water Tube Sectional Steam Boiler.



SAFE, ECONOMICAL, DURABLE.

Adopted by the Electric Light Companies of Cincinnati, Louisville, Columbus, St. Paul, Detroit, Jersey City, and many others; also by the Armington & Sims Engine Co., Providence, R. I., the Lynn Belt Line Street Railway Co., Lynn, Mass., and the Thomson-Houston Electric Co., Lynn, Mass.

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28 CLIFF STREET, NEW YORK.

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CHAS. E. ASHCROFT,
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V. MERRELL,
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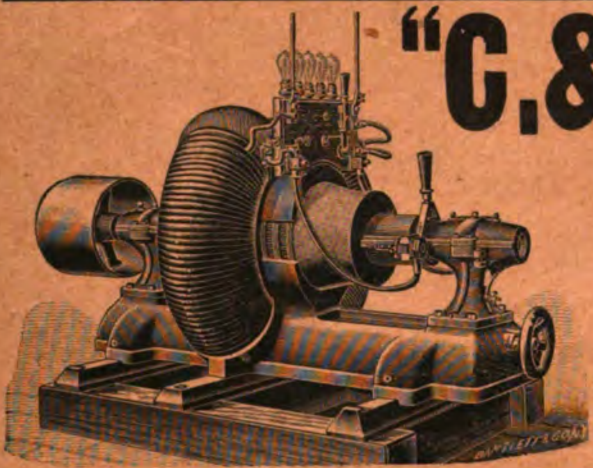
W. H. SMITH & CO.,
62 South Canal Street, Chicago.

KEATING IMPLEMENT AND MACHINE CO.,
Dallas, Texas.

"C. & C." ELECTRIC MOTORS AND DYNAMOS.



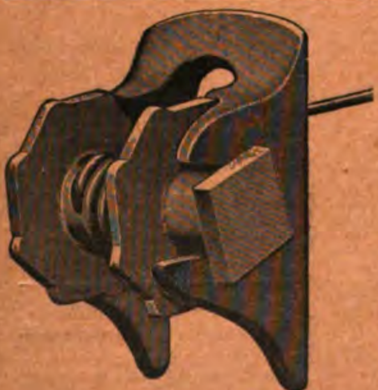
ELECTRIC MOTORS in all standard sizes, up to and including 100 H. P., for operating Elevators, Pumps, Printing Presses, and machinery for general manufacturing purposes.
POWER GENERATORS. ELECTRICAL MINING MACHINERY of all kinds, Hoists, Tram-Cars, etc.
FAN OUTFITS, Electric Plants for Pumping Church Organs.
DYNAMOS for isolated plants and the equipment of Mills, Banks and Office Buildings with Electric Lights.
ELECTRIC BLOWERS for ship ventilation. Have equipped 18 U. S. and foreign War Ships with ventilating apparatus.

New England Office, 63 Oliver Street, Boston. Philadelphia Office, 38 S. Fourth Street. Chicago Office, Phenix Building. San Francisco Office, 35 Market Street. St. Louis Office, 421 Olive Street. New Orleans Office, 78 Custom House Street.

We call the Special Attention of Station Superintendents to the fact that our machines are absolutely unsurpassed for economy of Electric Current.

The C. & C. Electric Motor Co., 402-404 Greenwich St., N. Y.

Why Use the Things?



Why not do without a Span-Wire Tightener? It don't take much time to bore a hole through the Pole and fasten the Span-Wire into an eye-bolt, and hunt around for the nut and washer, and find the monkey-wrench, and turn and twist until your arm is about ready to drop off. We have all the implements of war—the Auger, the Eye-Bolts, the Nuts and Washers, and the Monkey-Wrenches, and we also have

The Safety Span-Wire Tightener.

It is a simple arrangement and answers the question. You can put up 4 of them while you are getting the eye-bolt brigade into line. Made to use with iron or wood poles; and cheap.

The Electrical Supply Co.,

EASTERN OFFICE AND FACTORIES, ANSONIA, CONN.

RANDOLPH ST. AND MICHIGAN AVE., CHICAGO.

ILLUSTRATED CATALOGUES UPON REQUEST.

Press of C. C. SHELLEY, 10 and 12 College Place, New York.

BUSINESS DIRECTORY AND INDEX OF ADVERTISEMENTS.

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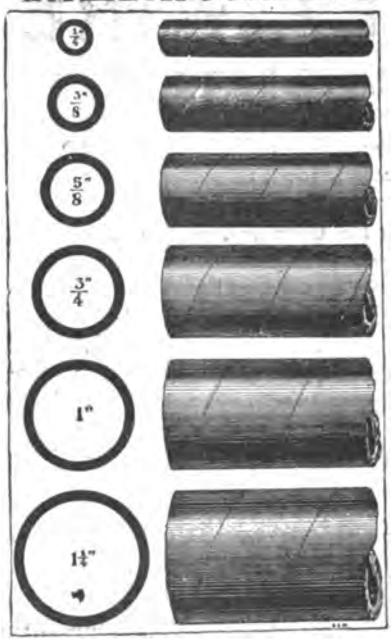
INTERIOR CONDUITS



TRADE-MARK.

WRITE FOR

New Illustrated Catalogue No. 4

: OF :

INTERIOR CONDUITS,
JUNCTION BOXES,
SWITCHES, CUT-OUTS,
AUTOMATIC SWITCHES,
INSULATING JOINTS,
AMPERE METERS,
AND OTHER ELECTRICAL SPECIALTIES

MANUFACTURED BY

Interior Conduit & Insulation Co.,

GENERAL OFFICES, 42 and 44 BROAD STREET, NEW YORK.

Works, 527 to 531 West 34th Street, and 526 to 528 West 35th Street.

THOS. DAY & Co., 222 Sutter St., San Francisco, Cal.
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AM'CAN ELECT. SUPPLY Co., 226 Pearl St., Buffalo, N.Y.
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GLOVER ELECT. Co., 127 West 8th St., Cincinnati, O.
CHAS. GABRIEL, Saginaw, Mich.
SOUTHERN ELECT. MFG. & SUPPLY Co., 110 Baronne St., New Orleans, La.
WALKER & KEPLER, 531 Chestnut St., Phila., Pa.
ELECT. SUPPLY & CONSTRUCTION Co., Pittsburgh, Pa.
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INCANDESCENT ÷ LAMPS

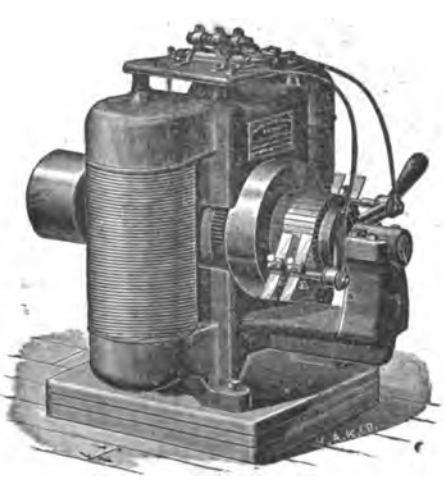
Prompt and Correct Execution of Orders.

STANDARD SOCKETS

In all styles—Key and Keyless; Wall, with Porcelain or Wood Base; Entirely Porcelain and Waterproof.

FULL LINE OF CUT-OUTS AND SWITCHES.

WRITE FOR PRICES.



A SIMPLE, ECONOMICAL, and DURABLE

INCANDESCENT DYNAMO

All Sizes from 20 to 350 Lights of 16 Candle Power.

ELECTRIC MOTORS

For Arc or Incandescent Circuit from 1-8 Horse Power up.

All machines of our manufacture have patent self-oiling bearings, and are complete in every mechanical and electrical detail.

AGENTS

BOSTON: The Eastern Electrical Supply and Construction Co., 65 Oliver St. NEW YORK: Chas L. Eidlitz, 10 W. 23d St. CHICAGO: The Thos. L. Johnson Co., 312 Dearborn St. MILWAUKEE: Henry Ramien, 641 Third St. WASHINGTON, D. C.: J. Geo. Gardner, 1005 H St. ST. LOUIS: Stagl Electrical Engineering Co., 1109 Pine St. MONTGOMERY, ALA.: W. F. Murphy. DETROIT, MICH.: The Michigan Electric Co., 212 & 214 Griswold St. MINNEAPOLIS, MINN.: J. M. Lennon, No. 22 Loan & Trust Building.

The Card Electric Motor & Dynamo Co., CINCINNATI, OHIO.

THE

Electrical Engineer.

VOL. XII. DECEMBER 2, 1891. No. 187.

MULTIPOLAR DYNAMOS AT THE FRANKFORT EXHIBITION.—II.

BY

E. Kolben.

THE field of the Schuckert dynamo in appearance is quite similar to the Fritsche field, but upon examination a considerable difference is found. In the Fritsche machine the poles directly opposite each other are of opposite polarity, but in the Schuckert machine these are of the same polarity. The Schuckert machine has a flat ring armature made out of a continuous iron band, and is wound in the regular manner with cotton-insulated copper wire. The largest machines of this type at present built are those at the central stations of Hamburg and Hanover, which have an output of 345 K. W. (300 volts and 1,150 amperes).

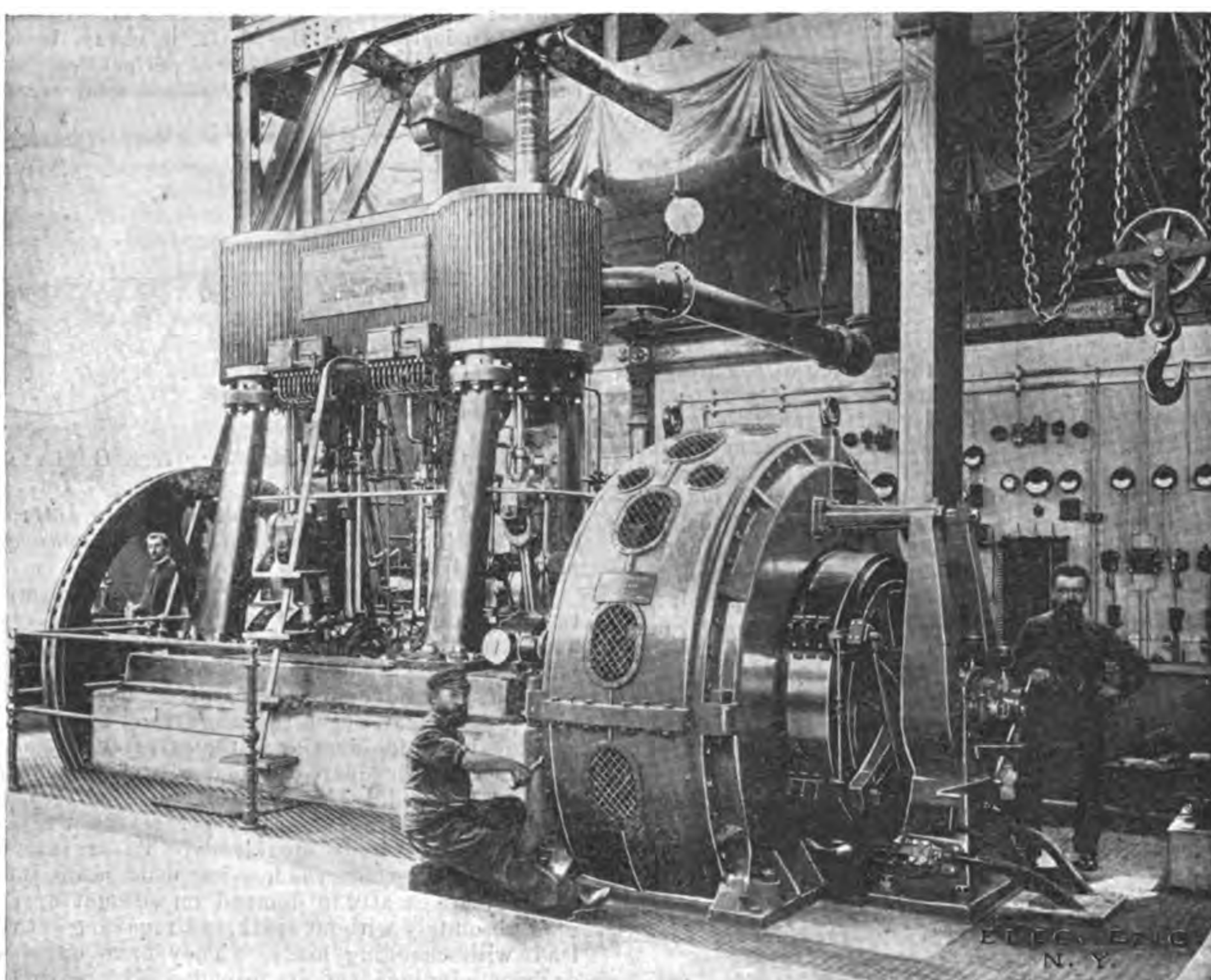


FIG. 9.—SCHUCKERT 220. K. W. MULTIPOLAR DYNAMO.

The exhibition machine is a 220 K. W. dynamo, illustrated in Fig. 9. It runs at a speed of 150 revolutions per minute, giving 220 volts and 1,000 amperes. The flat ring armature has an external diameter of 98 inches, so that the circumferential speed is 64 feet per second. This high circumferential speed, which is double that of the Siemens innerpole machine, is perfectly safe on flat ring armatures only, as the iron core is made of continuous bands, and, unlike a ring armature where the discs are made in part, will stand an enormous strain, due to centrifugal force. The strain on the external bands of the winding due to centrifugal force is also small, as the armatures are flat and narrow. The armature has a commutator the diameter of which is 5 feet, and which has 560 divisions. The armature is wound with two turns per division, and has a combined series and multiple arc connection. This is so made that four sets of brushes can be used. Thrust bearings are used, which permit adjustment of the amount of end play on the shaft.

No. 1, or Iron Clad Type.—The chief makers of this type are the Allgemeine Elektricitäts-Gesellschaft, Oerlikon Works and G. Kapp.

The machine of the Allgemeine Elektricitäts-Gesellschaft is made wholly of cast iron. They have not, however, developed larger sizes than their pattern G T-500, which is a 66 K. W. machine. The following data is given by the makers: Number of poles, 12; E. M. F. at terminals, 120 volts; current, 550 amperes; speed 220 revolutions per minute; total weight, 16,000 pounds; driving power required 103 h. p. (German horse-power = 736 watts). The commercial efficiency figures out at $\frac{66,000}{103 \times 736} = 0.87$, or 87 per cent.

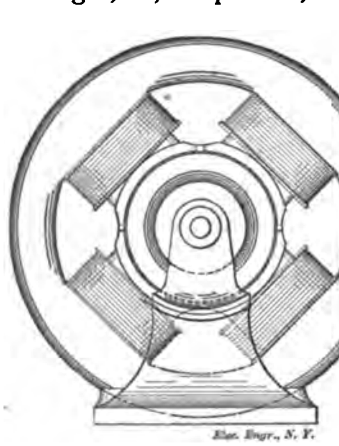


FIG. 10.—FIFTY-FOUR KILOWATT "A. E. G." DYNAMO.

The use of so many poles for a comparatively small sized machine is doubtless a miscalculation; this the makers acknowledge to be the case. A special feature of the magnet frame is a cast-iron pole bushing magnetically connecting all the poles, Fig. 10. It is a device of Mr. Dolivo von Dobrowolsky, who designed these machines. The object of this pole bushing is to reduce the weight of copper on the fields, sparking at the brushes, reduce the lead, and reduce the heating of the armature conductors due to eddy currents, as the conductors are made of rectangular solid copper bars arranged edgewise. With cast iron, and still more with wrought iron machines of this type, a spreading out of the core by means of a pole-piece of larger area becomes necessary, for it is not economical to operate at the same amount of magnetic induction per square centimetre in the air gap as in the iron. For if the iron induction density is high, then an enormous magnetizing power is required to overcome the air gap reluctance; and the weight of copper on the field magnets will very much increase the cost of the machine. If the induction density is made low in order to reduce the air gap reluctance, then the cross section of the cores would become too large. The machine would be heavy in iron, and also in copper, on account of the increased circumference of the magnet spools. A special outspreading pole-piece therefore becomes absolutely necessary in a well-designed machine. Instead of using special pole-pieces, which, if made separate, would be very awkward to finish, and would involve a large percentage of the cost of production in labor and special tools, a solid cast-iron bushing of special shape, Fig. 10, is introduced between the poles and a number of holes drilled in the neutral places. The frame can then be simply bored out, the spools slipped in position and the bushing driven in afterwards. The loss due to direct leakage from pole to pole is comparatively small on account of the very small cross-section and consequent high induction in the thin iron bridges left around the holes; this loss is more than counterbalanced by the simplicity and cheapness of the process of manufacture. The use of such a bushing, however, can only be recommended on cheap machines for small plants, where economy is only a secondary consideration. For central station work a machine made entirely of cast iron should not be used. The field cores, at least, should be of wrought iron or soft steel with outspreading pole-pieces.

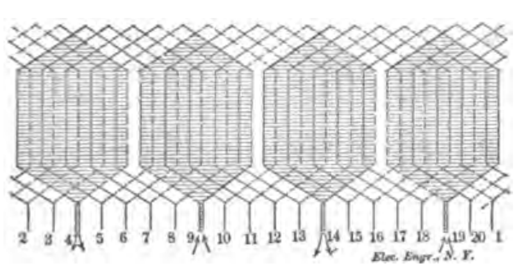


FIG. 11.—DIAGRAM OF MULTIPLE ARC CONNECTION FOR 4-POLAR DRUM WINDING.

The armature of the Allgemeine Elektricitäts-Gesellschaft machines are of large diameter and are provided with drum windings made up of copper bars of special shape laid upon the external surface of the drum, the cross-connections being made on the ends, as shown in the diagram, Fig. 11. The armature body is built up in a very solid manner, as will be seen in Fig. 12. The spider pulley supporting the body is of cast iron, and has fan-shaped arms, and is made in two halves, which are bolted together under hydraulic pressure. This construction is very substantial; it supports the armature discs all around, insulates them electrically from the shaft, is cheap, because only cast-iron is used, and it allows of perfect ventilation. Of course it can only be used for drum-wound armatures on account of the additional leakage on the interior of the body, which would be detrimental to armatures wound after the Gramme type.

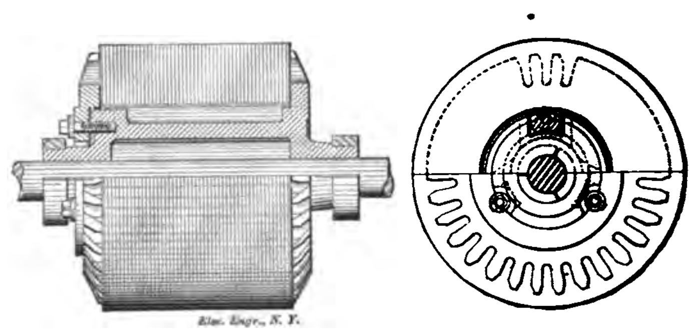


FIG. 12.—DRUM ARMATURE OF "A. E. G." DYNAMO.

Dynamos of the Oerlikon Works.—This company was the first to recognize the valuable features of type No. 1, and hence this type is sometimes called the "Oerlikon" or "Brown" type. The magnet frames are also made of cast iron, but they have no pole bushings nor extension pole-pieces. The material in the magnetic circuit is very heavy, as a low induction density in the cast iron, 3,500 to 4,500 C. G. S. lines per square centimetre, is employed and a very strong field used. The armature has comparatively few turns; about 80 ampere-turns per centimetre circumference, and runs quite sparklessly. These machines are, consequently, perhaps the heaviest machines in the market, but they are greatly in demand on account of their running absolutely without spark, and requiring but very small lead with changing loads. They have either Gramme or drum windings, and are provided with special commutators.

On sizes of larger output and large current capacities use is made of solid copper bars of circular section for winding the armatures. These bars pass through holes below the surface of the iron body, which entirely prevents the generation of eddy currents in them. According to C. E. L. Brown's experiments, a copper bar as large as two inches in diameter when placed in a hole armature does not heat at all, even when run in a very strong field. The bodies are supported by light brass spider pulleys, made in two halves, so as to clamp the discs tightly together, as shown in Figs. 13 and 14. No bolt holes are made through the discs.

The central station machines of G. Kapp, in London, have fields of Type No. 1, with cast-iron cores, wrought-iron extension pole-pieces and a cast-iron keeper, Fig. 15. The writer had an opportunity of discussing the design of this machine with Mr. Kapp himself, and found that he adopted this type of field for the same reasons which led the Edison General Electric Company, of this country, to adopt it for their large direct-driven central station machines, Fig. 16. This form gives the highest efficiency, is

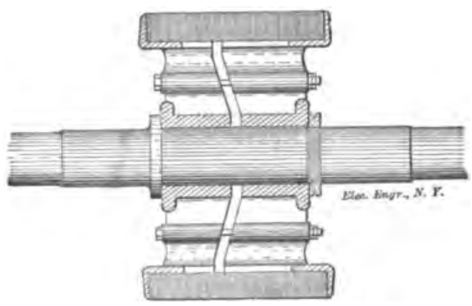


FIG. 13.—RING ARMATURE OF OERLIKON DYNAMO.

comparatively cheap to manufacture, has the best "running value" and does not spark. Kapp uses multiple arc drum winding and provides his machines with as many sets of brushes as there are poles. For large machines he uses flexible insulated cables of circular cross-section made of bare copper wire. According to tests made by him, this prevents eddies to the same extent as a cable stranded of insulated wires. The writer can fully indorse this practice from his own experience. Kapp finds objection to the wide, flattened cable of Crompton's, which, although it may prevent heating from eddies, nevertheless generates an E. M. F. within its own width, and causes wasteful currents within the cable itself. On a 120 K. W. machine an

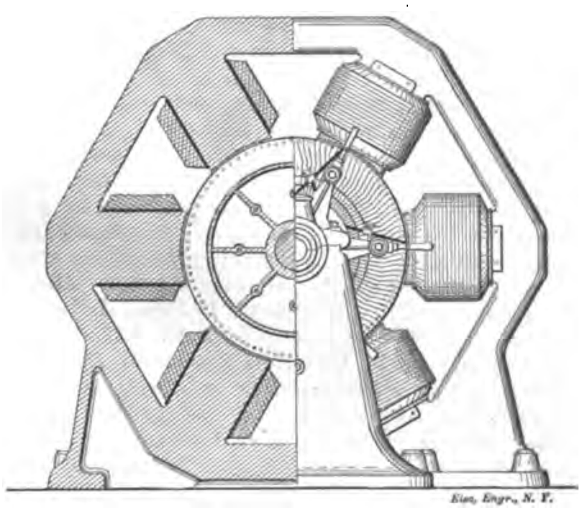


FIG. 14.—SIX-POLE OERLIKON DYNAMO.

experiment showed a gain of 7 h. p. in favor of using circular cable made of bare wire instead of the flat stranded Crompton cable.

BELT-DRIVEN DYNAMOS.

It is noticeable that there is a general tendency to reduce the speed of belt-driven machines, partly for mechanical and partly for electrical reasons. Mechanically, the friction in the bearings is reduced and the efficiency increased. Electrically, slow-speed machines permit the design of an armature of large diameter and large radiating surface, so that machines built on these lines have less tendency to heat than high-speed machines. The armatures of most dynamos of American make reach high temperatures, in fact temperatures which would not be considered safe by European makers. The main reason for this high temperature is that the induction density in the armature core is very high, and that the armatures have small diameters because the machines are required to run

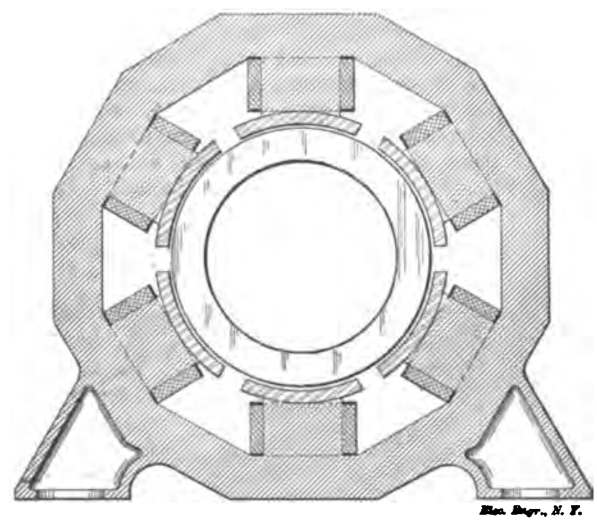


FIG. 15.—FIELD OF KAPP DYNAMO.

at high axle speeds. American machines are built on these lines on the score of economy, but a multipolar design now permits economy of manufacture together with slow speed. This fact points plainly to the gradual development of dynamo design. Many English makers are still building bipolar dynamos, but at the Frankfort Exhibition most of the belt-driven dynamos exhibited were of the multipolar type.

The Allgemeine Elektricitäts-Gesellschaft, Berlin; Oerli-

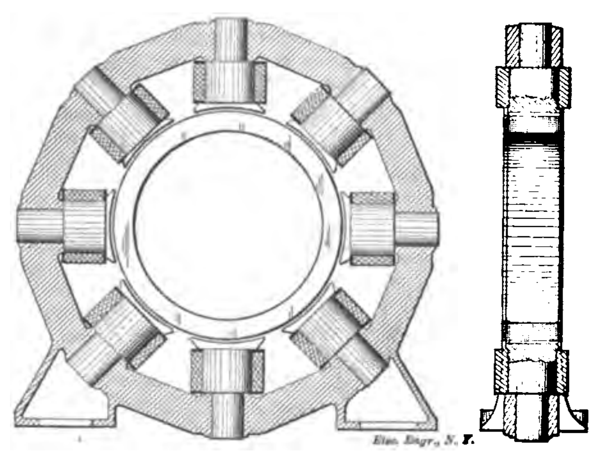
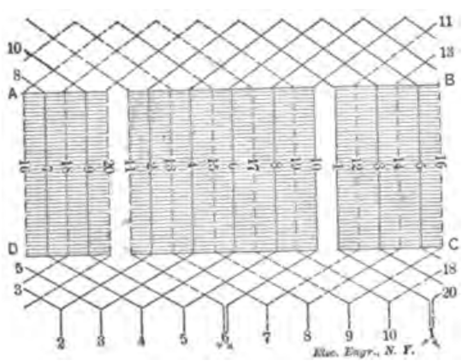


FIG. 16.—ONE HUNDRED KILOWATT EDISON GENERAL ELECTRIC CO. DYNAMO, WITH SOFT STEEL CORES AND CAST-IRON YOKE.

kon Works, Oerlikon; Siemens & Halske, Berlin; Schuckert & Co., Nuremberg; Lahmeyer & Co., Aix la Chapelle; O. L. Kummer, Dresden; Esslingen Machine Works; Naglo Brothers, Berlin; C. E. Fein, Stuttgart;—all make multipolar belt-driven machines. Either one of the three types of field already described for the direct dynamos is also used for the belt-driven machines. Nearly all have cast-iron field magnets, and here again Type No. 1 is generally used. Most of them have drum armatures with multiple arc connection, as shown in diagram Fig. 11, or with series connection, Fig. 17. In the latter case only two brushes are used. Machines of smaller output have toothed Pacinotti ring armatures.

The reason why the use of toothed armatures is limited to the smaller machines is because of the heavy armature effect which they necessarily exercise on full loads on account of the small air-gap reluctance, and also the fluctuations in the magnetic flux from tooth to groove, causing eddies in the teeth and heating them. A very satisfactory arrangement has been devised, by Lahmeyer, in combining tooth and surface winding; this is shown in Fig. 18. The body is toothed, and in winding this armature the grooves are wound with one set of coils first. This winding is then covered with insulation and a perfectly smooth surface obtained, on which a second set of coils can be wound. By this arrangement the air gap is reduced, as compared with a smooth armature, and at the same time a strong field can be produced economically without creating a heavy armature effect upon the field. In addition, the fluctuations in the magnetic induction are smaller because the depth of the grooves is reduced considerably, and the loss from eddies and hysteresis in the teeth is reduced to a minimum.



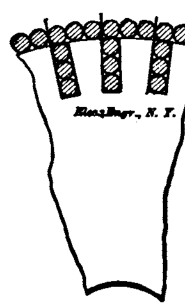


FIG. 17.—DIAGRAM OF SERIES CONNECTIONS FOR DRUM ARMATURES.
FIG. 18.—LAHMEYER'S COMBINED TOOTH AND SURFACE WINDING.

One of the lightest and cheapest multipolar belt-driven machines is the four-pole Oerlikon dynamo for ship lighting, similar to the new type of the Edison Co.'s dynamo shown in Figs. 19 and 20. To Mr. Kapp should belong the credit of first using this type of field. In it the length of the magnetic circuit is reduced to a minimum, and the machine is perfectly iron clad. This type has the great commercial advantage that the height of the machine is reduced, which makes it a very stable machine, particularly valuable as a motor. The field magnet frame can be cast with the bed plate in one piece, while one boring out with one setting of the tool is the only finishing operation on the frame. The type has been applied quite successfully in a form modified for the use of cast steel by the Edison General Electric Company, in this country. It is exemplified in their single-reduction street car motor, the excellent qualities of which the writer has had many opportunities of proving.

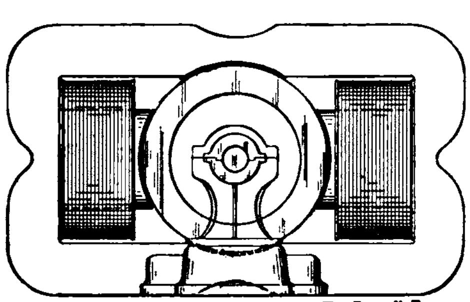


FIG. 19.—EDISON GENERAL ELECTRIC COMPANY'S 50-KILOWATT BELT-DRIVEN MULTIPOLAR DYNAMO.

From the universal favor that the multipolar machine has found on the European continent it is evident that electrically, as well as commercially, it has many advantages over the bipolar form. American electricians are quick to grasp the merits of any new development in electrical design and the American electrical industry is quicker still to find a field for it. There is no doubt that in the very near future the manufacture of multipolar machines will become quite general in this country, and with the superior commercial opportunities offered they will soon surpass their European models.

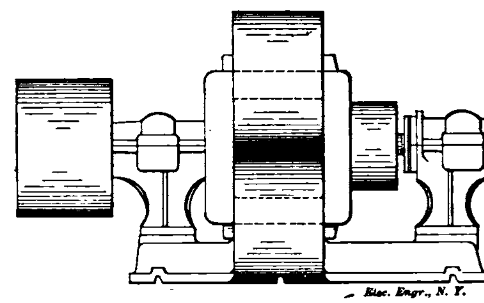


FIG. 20.—EDISON GENERAL ELECTRIC COMPANY'S 50-KILOWATT BELT-DRIVEN MULTIPOLAR DYNAMO.

THE BERLINER AND BELL PATENTS.

BY

Edwin J. Houston

THE recent issue of a broad patent to Emile Berliner for a microphone transmitter for telephones, a patent which is now the property of the American Bell Telephone Company, will undoubtedly attract considerable attention in this country, where inventors have been anxiously waiting for nearly seventeen years for an opportunity to improve the telephone service.

The ingenious defence of the original Bell telephone patent is so well known to the electrical world as to need no comment. It has been broadly held by the defenders of the original Bell telephone patent, and such contention has been sustained by the decision of the United States Supreme Court, that it practically covers all cases by means of which electrical undulations, similar in form to the sound waves accompanying the sounds produced by articulate speech, are transmitted over a line or conductor connecting a transmitting with a receiving telephone station.

In the litigation to which the original Bell telephone patent was subjected in the case of Dolbear, Judge Gray said, in speaking of the apparatus of Bell: "The evidence in this case clearly shows that Bell discovered that articulate sounds could be transmitted by undulatory vibrations of electricity, and invented the art and process of transmitting such sounds by means of such vibrations. If that art or process is (as the witnesses called by the defendant say it is) the only way by which speech can be transmitted by electricity, that fact does not lessen the merit of his invention, or the protection which the law will give to it."

"The mode or apparatus by which Bell effects his purpose is by using an electromagnet in the transmitter and another electromagnet in the receiver. But the essence of his invention consists not merely in the form of apparatus which he uses, but in the general process or method of which the apparatus is the embodiment."

The Berliner patent, number 463,569, of November 17, 1891, is exceedingly broad. Witness, for example, claims 1, 2 and 3.

"1st. The method of producing in a circuit electrical undulations similar in form to sound waves, by causing the sound waves to vary the pressure between electrodes in constant contact so as to strengthen and weaken the contact and thereby increase and diminish the resistance of the circuit, substantially as described."

"2d. An electric speaking telephone transmitter operated by sound waves and consisting of a plate sensitive to said sound waves, and electrodes in constant contact with each other and forming part of a circuit which includes a battery or other source of electric energy, and adapted to increase and decrease the resistance of the electric circuit by the variation in pressure between them caused by the vibrational movement of the said sensitive plate."

"3d. The combination, with the diaphragm and vibratory electrode, of a rigidly held opposing electrode in constant contact with the vibratory electrode, substantially as described."

I submit that considerable difficulty should be experienced by the American Bell Telephone Company in sustaining these claims in the courts for many reasons, among which I would note the following:

1. The prior state of the art; that is, the state of the art prior to the date of the filing of Mr. Berliner's application, namely, prior to June 4, 1877.

2. The public use which has been made of the alleged invention disclosed by Mr. Berliner's application during the many years that it has been allowed to slumber in the Patent Office, namely, between June 4, 1877, and November 17, 1891.

3. The repeated disclosure and publication in printed matter which has been made of the principles of this alleged invention or of the apparatus which it describes.

The prior state of the art concerning the invention of the telephone has been discussed in electric journals to such an extent that it is a matter of common history, and it is therefore not necessary to refer to it. It is sufficient to say that, apart from the modified form of "Bored Block" Reis Transmitter, in which a metallic contact point rests against a second metallic contact point suitably supported at the centre of a diaphragm set in motion by the sound waves produced by articulate speech, there would appear to be other anticipations of substantially the form of transmitter claimed so broadly in Mr. Berliner's patent.

But, leaving Reis' claims as to the invention of the articulate telephone out of the question, and assuming for mere matter of argument that Mr. Bell's original patent is valid, and bearing in mind the statement made by Mr. Bell in his original patent, number 174,465, dated March 7, 1876, namely, that "electrical indulations may also be caused by alternately increasing and diminishing the resistance of a circuit;" or, as claimed in claim fourth of said patent, "The method of producing undulations in a continuous voltaic circuit by gradually increasing and diminishing the resistance of the circuit or by gradually increasing and diminishing the power of the battery, as set forth," the question arises, Can the broad claims of the Berliner patent be sustained?

The invention of the microphone by Hughes is a matter of history. Assuming Mr. Hughes to be the first inventor of the microphone, after the disclosures of the method of transmitting speech by transmitting over a conductor electrical undulations similar in form to sound waves accompanying said sounds, and especially after the statement that such undulations may be produced by means of changes in the resistance, it will remain for the courts to decide whether any application of Hughes' microphone to the case of the telephone transmitter can properly, in view of the notorious public use of such applications, be regarded as such an invention as would justly entitle the holders thereof to seventeen years' monopoly of the apparatus and the processes it covers. And this also in view of the fact that so many years have been permitted to elapse between the date of filing such application and the date of issue of the letters patent for the same.

It is hardly necessary to add that the Berliner microphone patent referred to has been drawn up with exceeding skill. Witness the following disclaimer:

"I do not claim that I am the first inventor of the art of transmitting vocal and other sounds telegraphically by causing electrical undulations similar in form to the sound waves accompanying said sounds. Neither do I claim that I am the first who caused such electrical undulations by varying the resistance of an electric circuit in which a current is passing."

The validity of this patent, however, will without doubt be called in question, and it will remain for the courts to decide whether or not its exceedingly broad claims can be sustained. In the resulting litigation, which will beyond any doubt attend the holding of this patent, the voluminous literature which exists concerning the original Bell patent will afford a rich field for exploration and will furnish facts which will place many experts and witnesses *hors de combat* concerning views which they might wish to hold in order to sustain the Berliner patent.

THE ECONOMIC LIMITS OF LARGE POWER UNITS IN ELECTRIC WORK.

BY

Wm Lee Church

RESPONDING to the request of THE ELECTRICAL ENGINEER to contribute information on the above subject, it becomes a first duty to recognize the rare combination of mechanical-commercial judgment displayed by "Carleton" in his initiatory article in the issue of November 4. The editorial endorsement of him as a "practical man" in the only worthy sense of the term, is, on its face, "a work of supererogation."

I cannot refrain from repeating, at the outset, two of his statements for their terseness and force: "No well-organized and well-regulated gas company would put all of its gas into one holder, if such a thing were possible," and "The vital question to be considered by electrical promoters is not what a steam horse power costs at the station, as obtained from an improved and complicated engine designed to show at its official trial a unit of power for a pound and a fraction, of coal; but what does it cost to *produce light* commercially *at the permanent location of the lamp?*"

Are not these axioms? Both of them, and especially the last, should be printed in black letters and hung in a strong light over the desk of every manager.

But while "Carleton" is right in every particular up to the point where he stops, he stops too soon by just one step. Permit me to quote again: "The compound non-condensing engine has had quite a run, much to the disgust of the shareholder, who finds that, with variable loads and pressures, the direct-acting, non-condensing engine is more economical." In support of this opinion, which is unquestionably candid, he quotes briefly from the London *Engineering*, of which the full extract reads as follows: "Non-condensing compounds are built, but do not as yet give great satisfaction, unless carefully designed for a constant load. With variable loads, where the variation is great, they are of little value; until higher pressures become more common they are impracticable under such conditions. With good loads, such as to maintain constantly about six expansions and with 120 pounds boiler pressure, these engines have about the same economy as a simple Corliss non-compound engine with 80 lbs. boiler pressure."

He further confirms his position by the statement, which is understood to be literally true, that the Corliss Steam Engine Co. and the Armington & Sims Engine Co., builders, respectively, of long-stroke slow-speed, and short-stroke high-speed engines, refuse to build non-condensing compound engines.

Not only London *Engineering* and "Carleton," but, it would seem, all engine builders also, so far as I know, with but one exception, have reasoned and practiced along substantiated lines on the above facts, and in the end running against an apparently impassable conclusion, have said *finis*, and abandoned further investigation. Let us go briefly over the blazed line of facts, and see where the blind trail leads off.

Compounding, as to fuel duty, aims at two things: To utilize all the available pressure above the return pressure line (whether vacuum or atmosphere); and at the same time to reduce the resulting fluctuations of cylinder temperature by dividing them between two or more cylinders. To this the high-speed compound adds the further advantage of diminishing the *time* during which the low-pressure cylinder is open to the atmosphere or to vacuum. Since the economy of the engine varies, (*a*) in some inverse ratio to the terminal pressure exhausted, (*b*) in inverse ratio to the square of the differences of temperature, and (*c*) in inverse ratio to the duration of the exhaust, it will be seen how compounding makes for economy. The improved fuel duty thus obtained is indisputable in the case of compound condensing engines, and has become standard. But the same factors of economy,—utilization of pressure and division of temperature range—also exist when non-condensing. Then why not expect relative results? So we may; and get them too, so long as the load on the engine is heavy enough to keep the terminal expansion in the low-pressure cylinder always above atmosphere. But, unfortunately, this condition confines the engine to a very limited range of power; so limited as to take it practically out of commercial consideration, except in cases where both load and steam pressure are virtually constant, and the proportions of each engine can be designed with reference to its individual service. It naturally follows that compound engines have come to be rated nearer to their ultimate capacity than simple engines, in order to get further away from the fatal underload, and even then a variation of twenty-five per cent. in their load brings them down to the danger line. Now, no operator of electric interests needs to be told how far short this comes of meeting the requirements of a service in which the load varies from practically friction alone up to the utmost extension of the valve motion, every few hours in electric lighting, and every few seconds in electric railways.

Next; in just what way does underload kill economy in a non-condensing compound? To this question, the indicator diagram, Fig. 1, is a perfect answer. It was taken

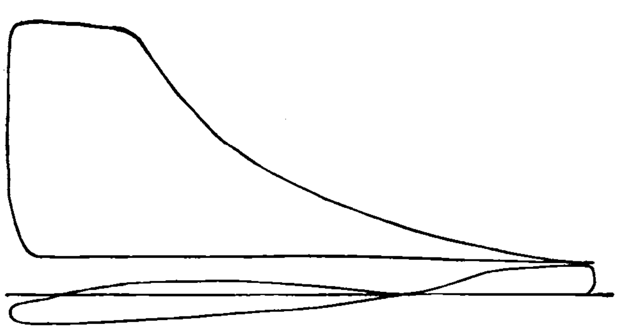


FIG. 1.

(not by the writer) from a Corliss cross-compound non-condensing engine doing ordinary mill work, and it will be seen that the load is by no means abnormally light, and really bears no comparison to the load found almost momentarily in any electric railway power station. For a better study of the work of the low-pressure cylinder a second diagram, Fig. 2, was taken from the low-pressure cylinder alone with a 10-lb. spring so as to magnify the results.

Now let us examine what the compounding of this engine did for its owner. It will be seen that the expansion line crosses the atmospheric line at a point representing $\frac{3}{10}$ of the stroke. The motive value of the low-pressure cylinder is represented by the area A D, equivalent in this engine to 50.4 h. p., and operating through $\frac{3}{10}$ of the stroke. For the remaining $\frac{7}{10}$ of the stroke, the low-pressure cylinder was dragged against an average vacuum of $5\frac{1}{2}$ lbs., and returned against an average back pressure of 3 lbs., representing a total resistance of 170.5 h. p. The net result of the low-pressure cylinder was, therefore, 50.4 *minus* 170.5 h. p., or a dead load, within the engine itself, of 120.1 h. p. What rational manufacturer would think of running an engine with 120 h. p. constantly applied to a brake on the band-wheel? Yet this is precisely what is done in this case. Or, to put it still more forcibly, the high-pressure cylinder was developing 186 h. p., of which 120 h. p. was used up in dragging the low-pressure piston against vacuum, and 66 h. p. was left for useful work, at the cost of a net fuel consumption far worse than the rudest full-stroke engine of fifty years ago.

I do not wish to be understood that this particular engine was put in for regular service under the conditions obtaining at the time the cards were taken. The engine

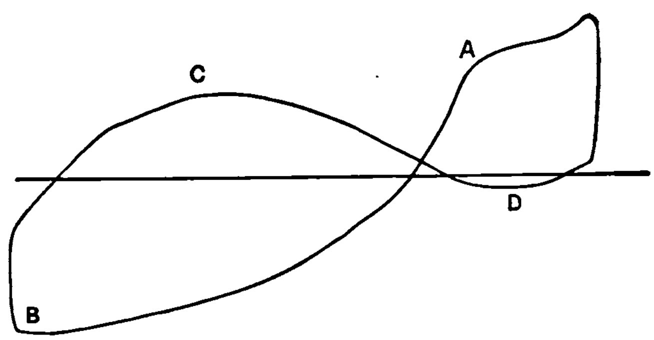


FIG. 2.

was ultimately intended to condense, and to carry a much heavier load, but in the meantime the proprietor was compelled to submit to the terrible performance shown by the diagrams. The engine was so piped that the low-pressure cylinder could not be temporarily disconnected, otherwise the engine might have been run on the high-pressure side alone, until such time as the increase of load would advantageously call for compound expansion. In a tandem compound engine it would, of course, be impossible to disconnect the two cylinders, and the dilemma is therefore unavoidable in all cases where the load and steam pressure and piston displacement cannot be at once definitely proportioned to each other, and the conditions allowed to remain unchanged. The cards are reproduced here as a general and striking illustration of what will inevitably take place with a compound non-condensing engine under a variable load, which is a simple recital of the conditions found in their most aggravated form in every electric railway plant.

From the foregoing it will be seen that decrease of load tells upon the compound engine somewhat sooner, and much more heavily, than upon the simple engine. The loss commences the moment the low-pressure expansion line crosses the atmosphere; or, more strictly, the moment it crosses a line parallel to atmosphere and at a distance above it representing the mean effective pressure necessary to carry the frictional load of the engine. The moment expansion falls to this point the low-pressure cylinder becomes an air pump for more or less of its stroke, the power to drive which must come from the high-pressure cylinder alone, enormously reducing the capacity of the engine and raising its fuel consumption to a point unpleasant to contemplate. In electric railways, particularly, the low-pressure cylinder of the non-condensing compound will act as a positive load upon the engine for the greater portion of the time.

Thus there has been ample ground for the statement made by your correspondent and the London authority. The fact that users of engines have been so quick to understand the nicer points of engineering involved is an evidence of the growing intelligence on the part of manufacturers whose business depends upon correct engineering, over which they have no direct control. Perhaps this intelligence has been fertilized in its growth by the "disgust of the stockholder" to which your correspondent graphically alludes.

Precisely this conditition of things confronted the writer and his associates when the question of compounding the single-acting engine was taken up by them some five years ago. It did not require any acute commercial instinct to understand that in order to command any general market a compound engine must not merely give a high duty condensing, but must give a proportionately high duty non-condensing, and that not only at its rated load, but at all loads. If this cannot be accomplished, then the compound engine is limited to those locations where there is sufficient water for condensing, or to other conditions where the load and the steam pressure are practically constant, and the engine can be proportioned with reference to them. This may be engineering, but certainly is not business. Understanding fully, as we did, the nature of the apparently inevitable dilemma, we squarely faced the following problem.

The compound engine to be commercially successful must show a high duty non-condensing. Being non-condensing, it must still be able to meet all ranges of load with economy. This is simply saying that the expansion in the low-pressure cylinder *must not* fall below atmosphere at any load, but must leave a mean effective pressure in the low-pressure cylinder sufficient to make it a motor and not a resistance. But how to do it? To be a motor the low-pressure cylinder must have steam, and this steam must come from the high-pressure cylinder, even when the high-pressure cylinder is cutting off at the earliest point. This immediately suggested a special high-pressure clearance large enough to hold a volume of steam that, passed into the low-pressure cylinder, would hold its terminal up to atmosphere even at the lightest load. Very good so far, and no harm done to the high-pressure economy, since the low-pressure cylinder gets the use of the steam anyway, and the higher expansion curve in the high-pressure cylinder is scarcely of theoretical loss. Yes, but here comes a trouble; there will be enough steam in this clearance to run away with the engine on the low-pressure side when the load falls of. No, for on the other hand a single eccentric valve motion can be made to give excessive compression at early cut-offs, and so we will use our large artificial clearance to hold in check a purposely early compression

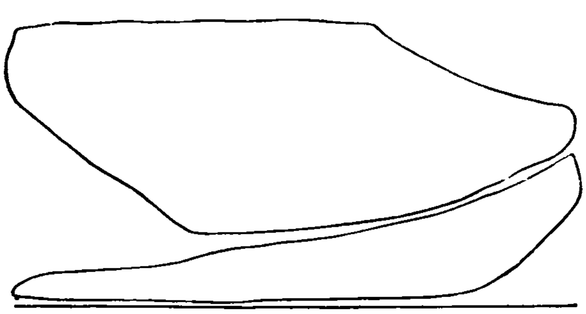


FIG. 3.

on the return stroke, which we otherwise could not stand. That is to say, we will use this special clearance on the first half of the return stroke to keep a little pluck in the low-pressure cylinder, and on the last half to cushion on, and so govern our engine on its compression. When you come to think of it, there is no reason why governing must necessarily be done by cutting off steam; it is just as well, in fact better, on several accounts, to do part of the governing by compression, to wit, a variable steam spring judiciously thrown in ahead of the piston, for the good reason that the steam spring not only gives out all the power it absorbs, but performs the very important function of keeping the temperature up into the bargain. This is one of the blessed things about a single eccentric governor, you can do these things so easily.

So now we have provided a means of keeping up the low-pressure terminal above atmosphere at all loads, and there is no longer any danger of making an air pump out of our low-pressure cylinder under any circumstances. It only remains to determine proportions, build an engine, and prove the theory by the test. To arrive at proportions, theoretical indicator diagrams were laid down and trimmed at until the best results were reached, and from these diagrams it was finally determined that the volume

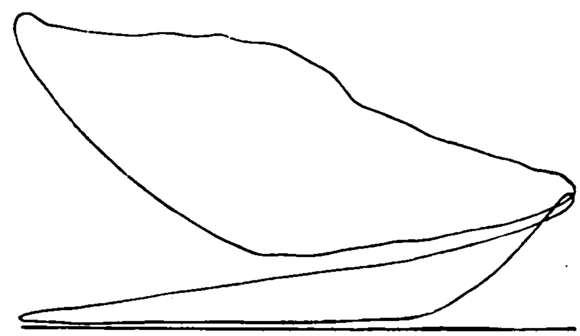


FIG. 4.

of the controlling clearance should bear the same ratio to the volume of the high-pressure cylinder that the latter bears to the low-pressure cylinder. This work was greatly facilitated by the fact that since the two edges of a single valve controled all the admission and expansion events on both cylinders, corresponding events were necessarily simultaneous at every point of cut-off.

The work of designing was next proved in the building of a 14-24x14 engine rating at 150 h. p. on 100 pounds steam. The engine was then sent to the test-room, where a surface condenser received all exhaust from the engine; but, being vented to the atmosphere, no vacuum was carried. Variable loads were supplied by a Prony brake, with check readings on the indicator. This method of test was somewhat unfair to the engine, as it left it charged with all water of entrainment and condensation in the pipes. The error was on the safe side, however. A number of tests were made covering a continuous period of months. At 120 pounds pressure non-condensing, the following average results in pounds of water per indicated horse-power per hour at the respective powers were obtained:

210	h. p.	22.6	pounds	of water	per	I. H.	P.
170	"	21.9	"	"	"	"	
140	"	22.2	"	"	"	"	
115	"	22.2	"	"	"	"	
100	"	22.4	"	"	"	"	
80	"	24.6	"	"	"	"	
50	"	28.8	"	"	"	"	

These tests were also repeated under variable pressures down to 60 pounds and gave approximately one pound more water for every drop of 20 pounds pressure. The highest water-rate obtained was 30.3 at 60 pounds pressure and 50 h. p.; that is to say, under conditions under which an ordinary compound engine would give a rating far worse than a plain slide-valve engine. Similar tests without number have been made during the last five years, both in the test-room and in service, and the fact is now conclusively settled that a compound non-condensing engine can be so designed, that so far from being unfitted for variable loads, it is of all engines the most uniform in its duty and the least sensitive to extreme fluctuations of load. And that, too, not by a slight margin, but by a difference so great as to solve the whole question of economy.

Figs. 3, 4 and 5 are diagrams from such an engine in use in the Wilmington Street Railway, Wilmington, Del. The point to notice is the persistence of the terminal pressure above atmosphere, even at the great range of load. We could fill every page of the ENGINEER with cards of this character from actual service, and none of them would show characteristics different from the above.

Another factor which entered strongly into the proportioning of the controlling clearance and the valve functions, was the desirability of dividing the load equally between the two cylinders at all points of cut-off. This is a result which it is practically impossible to get with the ordinary means of steam distribution in a non-condensing compound. If correctly proportioned for equalizing load at its rated horse-power, one or the other cylinder will take much more than its share, as the load varies either up or down. This is independent of the sudden break which takes place when the load allows the expansion to fall below atmosphere, as already discussed, and refers only to to those changes of load which occur between the maximum capacity of the engine and the least load which it will carry without expanding below atmosphere. It is obvious that equal division of load is essential to a refined economy, since one of the objects of compounding is to reduce the internal condensation to one-quarter in each cylinder, by letting one-half of the total fluctuation of temperature take place in each of the two cylinders. To get the maximum result, of course, demands that the range of temperature should be equally divided, since, if divided in any other proportion, one cylinder will have a greater range of temperature than it otherwise would have and would operate with correspondingly greater loss. The indicator

FIG. 5.

diagrams show how perfectly this has been accomplished, bearing in mind the ratio of cylinder volumes, which is in general about three to one.

It is an odd fact, which we have often observed, that many persons are skeptical about the results, simply from the absurd simplicity of the means employed. If they could see the "multiplicity of valves and intricate connections" which "Carleton" speaks of, they would probably admit the case; but the idea of doing so much by simply graduating the size of the neck of a spool-shaped valve looks out of proportion to the results. They are more apt to believe that we built the valve and invented the excuse.

I am much interested in the final paragraph of "Carleton's" article, as indicating how his impartial and intelligent search for good practice has led him to the same conclusion which we have already reduced to practice. He says: "Why not continue and proceed on this line of advancement, and arrive at the extreme power unit of the future for large central stations, which is to be a compound condensing (?) engine of 500 h. p., with a speed of not less than 200 revolutions per minute, and piston speeds of 600 or 700 feet? Stroke should be 18 inches or 20 inches, which will permit of direct-acting piston valves without complication. Armatures should be part of the engine shaft, and of as great a diameter as practicable, to compensate for the absence of driving pulleys or balance wheel; a most essential requisite. Simplicity reduces to a minimum the liability of disaster." Substitute for his limitation of a compound condensing engine the words, "compound engine, condensing or non-condensing, as circumstances may permit," and you have the case exactly. We seem to have followed these specifications to the letter in one of our present patterns, as witness the following dimensions:

Diameter of high-pressure cylinder.......	20 inches.
" " low-pressure "	36 "
Stroke	20 "
Speed, in revolutions per minute................	210.
Piston speed, feet per minute..................	700.
H. P. at 125 pounds pressure, non-condensing...	500.

A single direct-acting piston valve controls both cylinders from a single eccentric. This engine is now coupled direct to both railway generators and alternating dynamos of corresponding power on a single base as a unit machine. The armature is abundantly large to give the full necessary fly-wheel value. The point wherein we differ from your contributor is in the fact that in heavy station work the dynamo should necessarily be insulated from the engine and from the bed-plate, so as to prevent the coming in of ground leakage through the boiler and steam pipes. We therefore interpose a flexible insulating coupling; but, essentially, the dynamo is a part of the engine. In small isolated plants where ground currents are not to be feared, the armature is directly on the engine shaft close to the engine, and without any out-board bearing.

In view of the above discussion, it is interesting to see how completely builders have seemed to miss the one road which leads to compound non-condensing economy by contenting themselves with what is already known, and without attempting to meet new difficulties with new expedients. We find in a late circular such advice as the following, perfectly candid and exact from the standpoint of the builder, but wholly misleading as a general statement: "When compound engines are to be used without a condenser, high steam pressures are very desirable. Indeed, except with expert management, it is a questionable propriety to use the compound construction with steam of less than 125 lbs. pressure, and higher pressures are still more desirable from an economic standpoint Such engines should be most carefully constructed, and the builder should be made aware of the conditions under which they are to operate, that he may proportion the cylinders and design the working parts, so that the engine may do its work safely and to best advantage." The simple expedient of a controlled clearance unlocks the situation completely, and so far from the above limitations being impossible, compound engines, either condensing or non-condensing, can now be built of fixed proportions and carried in stock and shipped to fill any combination of conditions with the perfect certainty of a uniform fuel duty of the highest order. As high an authority as Prof. Thurston recognizes this fact in a leading paper in *Cassier's Magazine.*[1] Comparing the relative gain in compounding in slow-speed and high-speed engines, he says of the latter: "Compounding the single valve high-speed automatic engine reduces the consumption of fuel from about 3.5, or 4 lbs., to 3 or $2\frac{1}{2}$ lbs., the best practice being considered, the gain being thus a larger percentage in the less economical class of motor." The above is about the result got in ordinary practice with the compound non-condensing engine of the type under discussion, with a boiler evaporation of 8 to 10 lbs. of dry steam. It is also interesting to note that the fuel duty is very nearly as good in the smallest sizes of engine as in the largest. An actual fuel duty of better than $2\frac{1}{2}$ lbs. has been obtained under ordinary working conditions in a compound engine developing 35 h. p. non-condensing.

Another writer in the same magazine says: "Success is shown in the amount of business done through a period of years, and by the repetition of orders from the same locality or firms. For men are not so constituted as to be

1. See abstract of this paper on page 612.

easy victims to the same imposition the second and third times, and this point is frequently overlooked." This statement is the summation of all argument, and the evidence in this line lies in the fact that upwards of 600 engines containing the constant-clearance feature have been built and put in operation within the past five years, and of this number fully two-thirds are duplications of orders from two to thirty-eight times. These engines are not only operated by parties whose sole object in continuing business is to make money, but are to a large extent in the hands of concerns who are in themselves mechanics and engineers.

I have trespassed upon your space to an unwarrantable extent, but the subject is of the largest economic importance, and cannot be too well understood by manufacturers. So much misapprehension now exists on this point, and so many statements emanating from excellent, but not fully posted, authority, are now in circulation, that it becomes a direct challenge to a full exposition of the facts. I do not deem that I have transgressed propriety in the matter of advertising. The question under discussion is intensely practical, and practical affairs are in the hands of practical men, and if progress is progress at all, it is bound to turn up in practical shape in the form of business. No paper will more surely recognize this fact than The Electrical Engineer, and I consider that an apology for the above article is unnecessary.

TESLA'S ALTERNATING MOTOR OPERATED WITH CONDENSER.

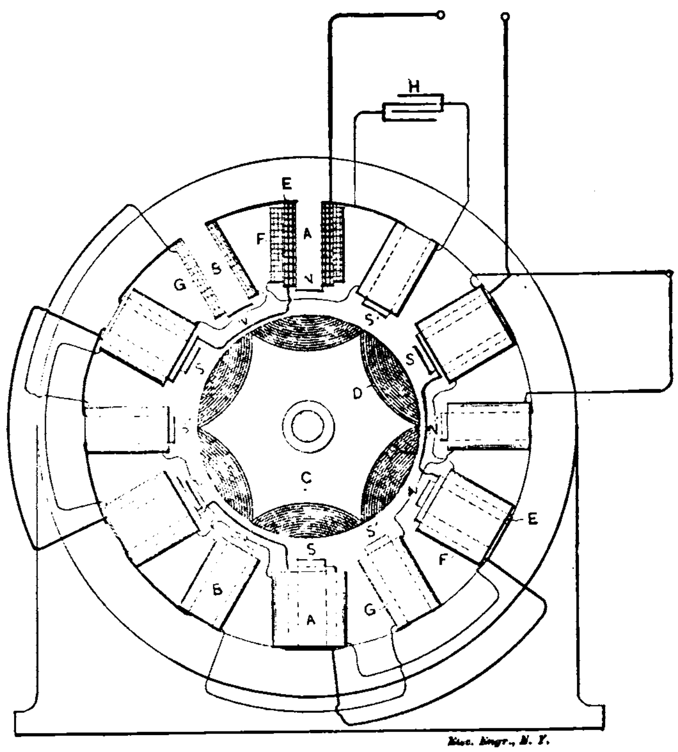
It is a well-known fact that if the field or energizing circuits of a motor, in which the action is dependent upon the inductive influence upon a rotating armature of independent field magnets exerted successively and not simultaneously, be both derived from the same source of alternating currents, and a condenser of proper capacity be included in one of the same, that approximately the desired difference of phase may be obtained between the currents following directly from the source and those flowing through the condenser. The great size and expense of condensers for this purpose that would meet the requirements of the ordinary systems of comparatively low potential, however, are practically prohibitory to their employment in practice.

Another well-known method or plan of securing a difference of phase between the energizing currents of motors of this kind is to induce by the currents in one circuit those in the other circuits, but no means have thus far been proposed that would secure in this way between the phases of the primary or inducing, and the secondary or induced currents, that difference—theoretically, ninety degrees—that, in the type illustrated, is best adapted for practical and economical working.

To accomplish this, Mr. Nikola Tesla has devised a means which renders practicable both the above described methods, and by which he is enabled to obtain an economical and efficient alternating current motor. Mr. Tesla obtains this result by placing a condenser in the secondary or induced circuit of his well-known type of motor, and raising the potential of the secondary currents to such a degree that the capacity of the condenser, which is in part dependent on the potential, need be quite small. The capacity of this condenser is determined, as usual, with reference to the self-induction and other conditions of the circuit so as to cause the currents which pass through it to differ from the primary currents by a quarter phase.

The accompanying diagram illustrates the principle as embodied in a motor in which the inductive relation of the primary and secondary circuits is secured by winding them inside the motor partly upon the same cores. Here A, B, represent the poles of an alternating-current motor, of which C is the armature, wound with coils D, closed upon themselves as is now the general practice in motors of this kind. The poles A which alternate with poles B, are wound with coils of coarse wire E, in such direction as to make them of alternate north and south polarity, as indicated in the diagram by N, S. Over these coils are wound long, fine wire coils F, F, and in the same direction throughout as the coils E. These coils are secondaries in which currents of very high potential are induced. Mr. Tesla, as a rule, connects all the coils E in one series and all the secondaries F in another.

On the intermediate poles B are wound fine wire energizing coils G, which are connected in series with one another and also with the series of secondary coils F, the direction of winding being such that a current impulse induced from the primary coils E imparts the same magnetism to the poles B as that produced in poles A by the primary impulse. This condition is indicated by the letters N′ S′. In the circuit formed by the two sets of coils F and G is introduced a condenser H, the circuit being otherwise closed upon itself, while the free ends of the circuit of coils E are connected to a source of alternating currents.



Tesla Motor With Condenser.

As the condenser capacity which is needed in any particular motor of this kind is dependent upon the rate of alternation or the potential, or both, its size and hence its cost, as before explained, may be brought within economical limits for use with the ordinary circuits. It is evident that by giving to the condenser proper value any desired difference of phase between the primary and secondary energizing circuits may be obtained.

EXHIBITION AT ST. PETERSBURG.

An international electrical exhibition is announced to be opened on 1st December, 1892, to extend to March 15th. The object is to show the Russian municipalities the various systems of electric distribution of light and power, and their particular advantages. Space has been retained by Ganz & Co., Siemens & Halske, the Continental Edison Company, and others. The tariff is about \$6.75 per square foot of floor space, and \$3.50 for wall space. The Russian railways will reduce the transportation charges by 50 per cent. for goods addressed to this exhibition.

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Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. XII. NEW YORK, DECEMBER 2, 1891. No. 187.

It has been computed that in a single cubic foot of ether which filled all space there were locked up 10,000 foot tons of energy which had hitherto escaped notice. To unlock this boundless store and subdue it to the service of man is a task which awaits the electrician of the future. The latest researches give well-founded hopes that this vast storehouse of power is not hopelessly inaccessible.—Prof. W. Crookes.

THE ELECTRIC AND THE STEAM LOCOMOTIVE.

THE discussion which has been called forth by recent publications on the possibility of applying electricity directly to the propulsion of trains on standard-gauge railways for both passenger and freight service has aroused the interest not only of the technical, but of the daily press. It is but natural to suppose that the journals devoted more especially to steam locomotion would follow this subject very closely as bearing particularly upon the nature of the motive power for railways, admittedly one of the most important branches of the service. It was with an evident recognition of this fact that the *Railroad Gazette* in a recent editorial took up the question of the feasibility of the application of electric locomotives for regular passenger and freight work, and showed, or attempted to show, just wherein electricity would fail. The writer in the *Gazette* cited the usual arguments to the effect that the various conversions of energy between the stationary engine and the motor on the track would entail a consumption of coal not inferior to that of the steam locomotive of to-day; and that the cost of operating the stations and the size of the conductors, etc., would make the expense of the undertaking prohibitory. Then he had also to consider that even if it were practical to run trunk lines with electric motors so far as the mechanical work was concerned, the question arose, What would become of the service in case the conductors were broken through an accident, such as would be caused by a washout or a wreck? Then we were also told that an electric motor would cost as much as a steam locomotive of equal power, and, finally the *Gazette*, although it mentions the City and South London motors of 100 h. p., asks to have pointed out to it a single instance where a 100 h. p. motor has been constructed, adding that what is needed for steam railroad work is an 800 h. p. motor at the least, since it is folly to talk of subdividing motors for train work, as has been proposed. With all due respect to our excellent contemporary, we may be allowed to remark that it does "protest too much." Every intelligent electrical engineer of to-day has well-defined ideas as to the limits to which electric construction is practical and economical, and this was clearly demonstrated a short while ago by Mr. O. T. Crosby in his admirable paper on high-speed long-distance electric railway work read before the American Institute of Electrical Engineers, in which he defined the limits above referred to, and which were arrived at as the result of an elaborate and painstaking investigation. Mr. Crosby showed that there were unquestionably commercial opportunities for the electric high-speed railway for trunk-line service, but when our contemporary throws down the gauntlet to electricians and challenges them to produce an electric locomotive of 800 h. p., it is apparently unaware of the resources of the electrical engineer. We venture to say that, if called upon to furnish such a motor, any one of the electrical companies engaged in electric railway work would undertake to furnish the same under guarantees, and indeed it may surprise our contemporary to learn that electric locomotives aggregating very closely in power the figure named by it have been quite recently designed in anticipation of the near demand for such a machine. The actual progress in this direction is well illustrated by the standard gauge Thomson-Houston electric freight locomotive which we illustrate in another column. Our contemporary has also, in substantiation of its arguments, stated that a standing offer had been before the electric companies of Europe for a whole year to equip one of the new elevated roads in Chicago with a system for the propulsion of cars by electricity. This we must confess is news to us, and we can only say that if the same offer has been made to any of our large companies in this country, the contract would probably not have gone begging. As a matter of fact, we have ourselves inspected well worked-out American designs for the electrical equipment of this very road. As our contemporary remarks, it is a big jump from 100 to 800 h. p. in electric locomotives, but it is not so long since, that far lesser marvels were considered impossible in steam railroading, and we have no fear that when electric locomotives of such size are called for, they will be forthcoming, and promptly, too. It would be strange indeed, if the electrical engineer who has succeeded in entirely revolutionizing surface street railway traffic in the space of a few years, should not be equal to the task of equipping a road, such as the Chicago elevated, which offers every advantage for the application of the electric motor.

THE MOST ECONOMICAL STATION POWER-UNIT.

THE discussion on this most important subject is taken up in this issue in a manner which brings out prominently some points in steam engineering that are still matters of dispute. Mr. Church argues well for the economy, when properly designed, of non-condensing compound engines employed in work involving widely fluctuating loads. The means employed for obtaining this economy are well worthy of the closest study, and the results obtained by utilizing high compression in the low-pressure cylinder are remarkable, considering especially the simplicity of the means depended upon to effect them. While Mr. Church differs from "Carleton" as to the means for obtaining high economy, he agrees with him as to the size of the future power unit, which he places at 500 h. p. with an engine running at a speed of not less than 200 revolutions per minute, and piston speed of 600 or 700 feet, with the armature directly connected to the engine shaft. Nevertheless, while the writer in this issue appears to differ in only one, though an important, point from "Carleton," we have still to hear from others whose ideas of engine practice in connection with central station work may be characterized as radically opposed, and involving the economy of the high-speed direct connected, as against the slow speed with countershaft.

MULTIPOLAR DYNAMO MACHINES.

A CLOSE analysis of the changes and improvements which have marked the progress of dynamo electric machinery during the last ten years reveals the fact that, as in many other arts, it has required some time to effect modifications which of necessity entail the discarding of much valuable material and the expensive abandonment of old processes. In no one direction have more marked changes taken place than in the design of dynamos, and more particularly in the adoption of the multipolar type of field. Looking for the course of events which have led to this type, it will be hardly denied that the mechanical success of the multipolar alternating machine contributed not a little to the rapid recognition of the merits of that type of construction, wholly aside from its electrical properties. The direct mechanical and electrical advantages of the multipolar type of continuous current machine are well pointed out and discussed in our columns, by Mr. E. Kolben, who describes the machines of this type exhibited at the Frankfort Electrical Exposition, and thus affords the student a valuable means of comparison of the relative merits of each practical type. But aside from the advantages obtained in the operation of these machines, practical experience has demonstrated the important fact that their cost of manufacture is considerably below that of bi-polar machines of equal output. It is true that the construction of the commutators of such machines may involve an expenditure in excess of that required for the ordinary bi-polar type, but the saving in weight of material as well as in the machine work required in multipolar machines far overbalances this single disadvantage. But even this drawback, it is safe to assume, will be overcome at no distant day by the introduction of special machinery. Hence, even if the multipolar machine offered no other advantages, its reduced cost of manufacture in these times of lively competition would be a powerful factor in its adoption by dynamo manufacturers, and one can clearly discern the drift in this direction. The question naturally obtrudes itself at this point as to the limits to which the increase in the number of poles should be pushed. While this consideration, as applied to alternating machines, would be governed largely by conditions of working, number of alternations, etc., the necessity for a commutator in continuous current introduces a factor which cannot be ignored in any commercial apparatus, and more especially in that under consideration, and that is, simplicity. In this direction, therefore, we must look principally for the limit in multipolar continuous current machines. And this again brings out prominently the immediate necessity for, and general applicability of, a continuous current machine without a commutator. We venture to predict that this machine or apparatus when introduced will be multipolar in its character, and that it will bear close relationship with alternating apparatus, which has recently been the subject of so much interest and discussion.

OPERATING ALTERNATING MOTORS WITH CONDENSERS.

THE operation of alternating motors by currents differing in phase has called forth a number of methods for obtaining the lag required to secure a high output and efficiency, and the most recent development in this direction is exemplified in the application of the condenser for this purpose. In the methods thus far proposed, the condenser was designed to operate at the same potential as the motor itself, usually a low one, and hence to obtain the required capacity necessitated the employment of condensers of such size as to make this otherwise advantageous assistance prohibitory. As the capacity of a condenser, other things being equal, is a function of the potential, Mr. Tesla very ingeniously operates the condenser at a greatly increased E. M. F. generated directly in the motor itself by secondary coils arranged on the magnet limbs. By this means, evidently, the size of the condenser is proportionally reduced, and at the same time the lag desired obtained in a motor requiring only two wires for its operation. In this manner Mr. Tesla is enabled to operate any of his types of motors either with two or more phases. It will be observed that the working conditions in the type of motor illustrated are such as to insure a maximum output and efficiency with such a combination. The cores which perform the office of transformers are made to work as transformers under overload with a closed inductionless secondary, and the primary current passes through at a low E. M. F., and the poles developed in the armature are made to coincide with those developed in the auxiliary cores. While the latest arrangement of Mr. Tesla's is highly ingenious and reduces the cost of the condenser, it seems impossible that as high economy can be obtained with this method as compared with the ordinary system devised by him, and involving the use of differential phase generators. Mr. Tesla also employs currents of high frequency in connection with his condenser motor, with the object of reducing the cost of the condenser.

OSCILLATING MAGNETIC FIELDS.

BY

ALTHOUGH the rotary field system received only passing notice from electricians, when it was first brought to light by Messrs. Tesla and Ferraris, a few years ago, this has more than been compensated for by the marked attention it is now receiving. That the system and principles first used and laid down by the inventors should have received so

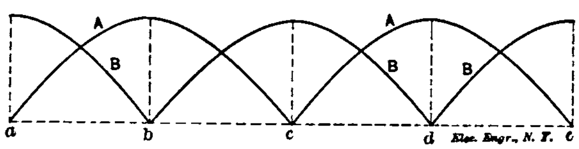
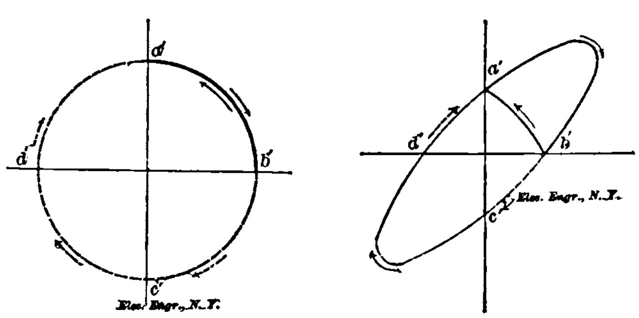


FIG. 1.

little development until now is rather phenomenal, and especially so, considering the period which has elapsed since its discovery, was one of great activity in every branch of applied electricity. Perhaps one of the explanations of this apathy is that there has been some doubt as to its commercial value, on account of the failure of Mr. Tesla to introduce his motor in a general commercial way, it being applied only in a few isolated cases. That the system which has been so elaborated by Messrs. Dobrowolsky and Brown will be more successful than that of their predecessor we must wait for time to decide. But I cannot



FIGS. 2 AND 4.

help but feel that a principle, which is in itself so simple and beautiful, must have a prominent place among the many future applications of electricity. In fact, we can already point to the case where it has solved the meter question as far as alternating currents are concerned, and as time goes on many more uses will be found for it; besides, the principle is sure to receive new development, now that attention is again called to it, and many of its difficulties will be cleared away.

What I want to call attention to is a branch of the subject, which, as far as I am aware, has never before been

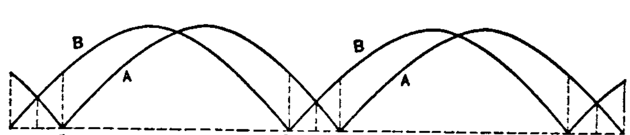


FIG. 3.

touched upon. I shall only deal with it in its most simple aspect, but this will be sufficient to illustrate the principle. We will suppose that an ordinary four-coil Tesla motor is used and, to still further simplify matters, that the armature is without windings, though this simplicity is by no means essential.

First, let us study the law which the resulting pole follows, as regards strength and direction when the phase difference of the two currents has any value α, and the amplitudes are unequal and denoted by A and B. As the component poles are at right angles, we can use these values as co-ordinates of a curve, which will show the law of variation. Thus we have:

$$x = A \sin p\, t,$$
$$y = B \sin\, (p\, t + \alpha),$$

By trigonometry;

$$y = B \sin p\, t \cos \alpha + B \cos p\, t \sin \alpha.$$

Substituting from above, we have:

$$y = \frac{B}{A}\, x \cos \alpha + B \sqrt{1 - \frac{x^2}{A^2}} \sin \alpha.$$

Transposing, squaring and reducing,

$$A^2 y^2 + B^2 x^2 - 2\, A\, B\, x\, y \cos \alpha - B^2 A^2 \sin^2 \alpha = 0.$$

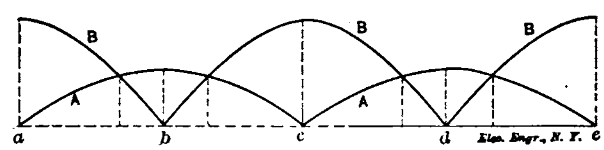
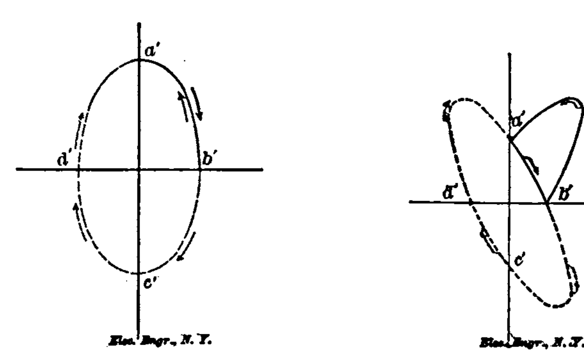


FIG. 5.

This equation we know from treatises on conic sections is that of an ellipse, whose centre is the origin of the co-ordinates, but whose axes are oblique to those of the co-ordinates.

Now, let us examine the form which these curves will take, where, instead of an alternating current, we use those that have been commutated, and, assuming for the present that the commutation takes place instantaneously, where the currents reach their zero values and there is no reaction to change the form of the current curves. Let us take as a fresh case that which is the simplest, viz., two currents of equal amplitudes, but differing by a quarter phase.



FIGS. 6 AND 8.

Referring to Fig. 1 we see that we have the following series of relations:

$x = A \sin p\, t,$

$y = A \cos p\, t,$ between a and b;

$x = A \sin p\, t,$

$y = A \cos p\, t,$ between b and c,

$-x = A \sin p\, t,$

$-y = A \cos p\, t,$ between c and d, and

$-x = A \sin p\, t,$

$y = A \cos p\, t,$ between d and e.

If there had been no commutation, the curve would have been the circle shown by the dotted lines in Fig 2; but on account of the commutation which changes the sign of y, between b, c, Fig. 1, our values, instead of being represented by the portion of the circle b^1, c^1, Fig. 2, are represented by b^1 c^1 that is, the same values, gone over in going from a to b, only repeated backward, and also by the

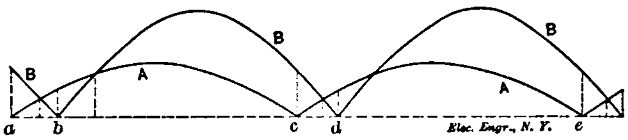


FIG. 7.

double change of signs between c, d, we get instead of c,' d^1, a repetition of a^1, b^1, and similarly as regards d, e, and d^1, e^1. So we see that our resulting pole, instead of revolving, oscillates back and forth inside of an angle of 90°, and in this case remaining constant in strength.

Using the same reasoning as above for the case of equal amplitudes, but of any difference of phase, we get what is shown in Figs. 3 and 4, and for unequal amplitudes, but a quarter phase difference, Figs. 5 and 6; and again for unequal amplitudes and any difference of phase, Figs. 7

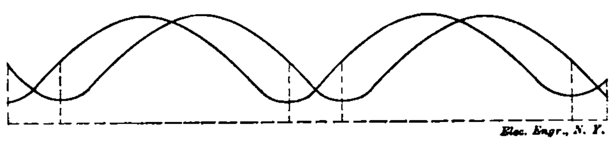
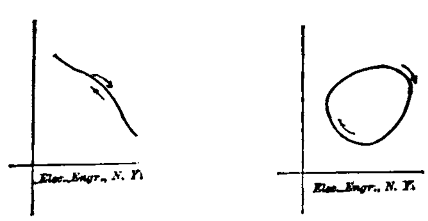


FIG. 9.

and 8. By inspecting the curves of Figs. 3, 4, 6 and 8, we see that the magnetic poles, whose actions they represent, would so act on the armature of the motor mentioned as to produce rotation, except in the case where the phase difference was a quarter, because the average strength of the pole going one way is greater than when going the other. There will be in practice a slight modification of these curves due to the fact that the assumptions we made about commutation being instantaneous, and about reactions, are not quite correct. The actual form of the current curves will be as shown in Fig. 9, which will modify, as an example,



FIGS. 10 AND 11.

the curves shown in Figs. 2 and 3 to those shown in Figs. 10 and 11; an inspection of which will show that this change will not effect the general principle given above.

That an oscillating field system has any commercial application it is very difficult to say at this time; the difficulty of commutating high E. M. F.'s stands rather in the way, but as these are direct currents, and have nearly all the good properties of that system, I should not be surprised if it were turned to some practical use.

BUILT BY STUDENTS.

Comparatively few people are aware that Chicago has a building almost wholly built by the students of an industrial school. The new building of the Institute of Technology, 147 Throop street is the first building west of New York City ever put up wholly, or in part, by students. No better evidence of the practical character of the instruction of a school could be desired.

The teaching of trades is in accordance with the broad plan of this Institute, which proposes to teach "any person, any study, day and evening." It now announces the organization of evening classes in electricity, plumbing and bricklaying, as well as architure and engineering, beginning Dec. 1 next. Draughting of all kinds is made a specialty, three instructors being employed.

HOEPFNER'S ELECTROLYTIC PROCESS FOR EXTRACTING COPPER AND SILVER DIRECTLY FROM ORES.

FOR a number of years electro-metallurgists have endeavored to establish between the electrolysis and the lixiviation of ores a process constituting a cycle, in such a manner that the lixiviating liquid is produced by electrolytic means in the baths, and that the original electrolyte is reproduced by the chemical process of dissolving the parts of the ore which contain metal. Now it will at once be noticed that in this case not only the arrangement of the baths, but also the chemical composition and the circulation of the electrolytes, must be of the highest importance.

Dr. Hoepfner, of Giessen, in carrying out his new electrolytic process (German Patent No. 53,782, dated March 2, 1888) employs a bath or a system of baths divided by diaphragms into two compartments. One compartment of the same contains anodes that cannot be dissolved by electrolysis, and the other compartment cathodes of sheet copper.

A solution of a halogen salt and cuprous chloride circulates by itself past the anodes, and a similar solution flows past the cathodes. At the latter is precipitated metallic copper, namely, 2.36 grams for each ampere-hour, or double as much as is deposited by the current unit when use is made of a solution of an oxide salt, such as, for instance, a solution of copper sulphate.

At the anodes free chlorine would be produced if no cuprous chloride were present there; accordingly a tension of 1.8 volt would be necessary at the poles. The chlorine, however, at once combines in the nascent state with the cuprous chloride, always present, to form cupric chloride. By this means is produced an electromotive force which, as experience shows, amounts to about one volt, and by which the work of the current profits. Therefore, the electrolysis proceeds practically with a tension of only 0.8 volt at the poles.

Cuprous chloride (Cu_2 Cl_2) develops in its formation 65.75 calories. Now as 45 calories of heat thus developed correspond to one volt of electromotive force dissociating power, $\frac{65.75}{45}$ or 1.46 volt is that electromotive force in volts which is needed for decomposing Cu_2 Cl_2 into Cu_2 and Cl_2.

But in order to overcome the resistances in practice the potential must actually be increased to 1.8 volt, as with 1.46 volt the dissociating and combining power only just balance each other, so that a quantitative decomposition cannot as yet take place.

When, however, chlorine in a nascent state oxidizes the cuprous chloride present at the anodes, the following action takes place:

$$Cu_2\ Cl_2 + Cl_2 = 2\ Cu\ Cl_2.$$

As 2 Cu Cl_2 represent 125.4 calories, 125.42 — 65.75, or 59.67 calories become free and aid the work of the current. Theoretically the electrolysis therefore commences in Hoepfner's process when applying only 65.75 — 59.67 = 6.08 calories, or 0.13 volt.

The liquor at the cathodes, while it flows past a number of cathodes in succession, becomes poorer in copper and is ultimately almost free from copper. It then leaves the electrolytic bath and is reserved for further use in the process forming the complete cycle above referred to. The liquor at the anodes retains the quantity of copper it contains. The copper is, however, ultimately not present as cuprous chloride, but as a liquor of cupric chloride; the latter now leaves the electrolytic bath as a continuous current.

At the electrodes the following action takes place: Cu_2 Cl_2 yields 2 Cu to the cathode plates. By an electrolytic displacement of atoms, Cl_2 passes to the anode and combines with $Cu_2\,Cl_2$ to form $Cu_2\,Cl_4$, or $2\,Cu\,Cl_2$.

For one atom of separated copper there is therefore formed one molecule of $Cu_2\,Cl_2$ at the anodes.

The solution of cupric chloride coming from the anodes is then employed for extracting the copper and silver from milled copper and silver ores. For this process special lixiviating apparatus is employed.

In copper ores containing sulphur the action, for instance, takes place according to the following formula:

$$Cu\,Cl_2 + Cu\,S = S + Cu_2\,Cl_2.$$

This shows that the liquor of cuprous chloride formed has taken up exactly as much copper as had previously been precipitated by electrolysis as metallic copper. As compared with the quantity of copper the concentration of the liquor is now double as much as before. In order, therefore, to re-establish the original concentration, the liquor which was deprived of the copper and had flowed from the cathode cells, and which, as above stated, was reserved, is added again to the liquor which had come from the anodes and was used for the lixiviation of the ores. Of course this mixing of the liquors may be effected at once when they flow from the electrolytic bath, so that in the lixiviating apparatus the original concentration is already re-established.

The regenerated solution of cuprous chloride flows again to the anodes and cathodes; at the former the chloride is formed, while at the cathodes the freeing from copper takes place. With the solution of chloride is mixed the part of the liquor which is freed from the copper; the mixture passes to the lixiviating apparatus, and so on. It will therefore be seen that there is a continuous process forming a cycle.

It deserves to be especially mentioned that simultaneously with the copper, any silver which may be contained in the ores is dissolved, which is not the case when use is made of the other extracting liquids, such as, for example, when ferric sulphate is employed.

The cycle is disturbed only by the gradual dissolution of small quantities of iron, arsenic, antimony, bismuth and the like in lieu of the copper. These impurities must not be precipitated at the cathodes, because the quality of the precipitated copper would be greatly reduced thereby. Moreover, by a greater quantity of iron in the liquor, the dissolving capacity of the latter for copper is diminished to about one-third, as has been found in practice. This defect is, however, effectually obviated by the removal of such impurities, more especially the iron from the liquor, by the purely chemical method through the medium of oxides of copper, before the liquor is conveyed to the cathodes.

Simultaneously with the iron disappear from the liquors, as proved by experience, the arsenic, bismuth, antimony and, generally, all these substances which may pollute the copper.

Any silver which may be contained in the liquors derived from the extraction is either separated by electricity, then deposited on the first cathode plates of the first bath, or by chemical means before the precipitation of the copper. The resulting copper is therefore chemically pure, or it contains, like all electrolytic copper, only very small traces of impurities that do not diminish its value in any respect.

As regards the commercial value of this process, it possesses several advantages which are such as to raise it above nearly all similar processes which have hitherto become known. In the first place, the effect of using solutions of cuprous chloride is that with the same expenditure of current, double as much copper is produced as in the electrolysis of solutions of sulphate. By this means the cost of the electrolytic installation is reduced to one-half.

In the second place the halogen salts of the alkaline and earthy alkaline metals possess such dissolving capacity for cupric chloride and cuprous chloride that, in the case of solutions which are free from iron, the treatment can be effected with concentrations, which cannot even be remotely attained with solutions of sulphate.

From this it follows that with the slight volume of the liquor to be moved in Hoepfner's process also the lixiviating apparatus can be constructed at much less cost than in the case of other similar electro-metallurgical processes.

Lastly, it may be mentioned as a considerable advantage that even from the most impure, that is to say, comparatively valueless, ores, almost chemically pure copper can be produced, and that from ores containing silver also the latter can be extracted simultaneously.

From the following calculation it follows that by Hoepfner's process 43.9 kilograms of copper can be produced with one (1) horse power.

A mechanical horse power gives, with large dynamos, 690 (volt-amperes) watts; at 0.8 volt, therefore, 862 amperes. As, for every ampere hour, 2.26 grams are precipitated, this gives for 862 amperes in 24 hours:

$$\frac{862 \times 2.36 \times 24}{1,000} = 48.8 \text{ kilograms.}$$

Deducting 10 per cent. loss, 43.9 kilograms remain for 1 horse power per day.

When larger direct coupled steam engines are employed, one (1) horse power in the same time requires 30 kilograms of coal, as is well known.

If, then, the work of the necessary pumps and for the mechanical movement of the lixiviating apparatus is reckoned at ($\frac{1}{4}$) one-quarter, and the electro-dynamic power at ($\frac{3}{4}$) three-quarters of the entire work required, it follows that by Hoepfner's process, including a loss of current of 10 per cent., nearly 33 kilograms of chemically-pure copper are obtained from milled ore with 30 kilograms of coal, a result which has not heretofore been attained and which enables even the poorest copper ores to be utilized. This is the more so, if the lixiviated, very finely pulverized residues need not, like, for instance, the peacock ores, be used for the production of iron.

It is evident from the foregoing statements that Hoepfner's process, which is already in use in Silesia, Westphalia, Norway, etc., has been technically worked out to its smallest details and will in future probably attain to great importance. It will no doubt become particularly valuable for those countries in which coal is dear, as, for example, in Spain, South Africa, and in Chili, which is the most important copper-producing country of South America, especially as it is also adapted for the extraction of silver with or without the simultaneous production of copper.

ELECTRICITY IN OYSTER CULTURE.

An application of electricity to the cultivation of oysters has recently been made by Mons. Lacase Duthier, the well known authority on oyster culture. He makes use of the electric light in examining the stages of development through which the spawn passes. A glass cylinder is mounted in a cylindrical skeleton cage which serves as a support; into this glass the water containing the spawn is placed. At the bottom is a plane, silvered reflector; the cover forms a parabolic reflector in the centre of which is fixed a small incandescent lamp. The reflectors and the sides of the glass cylinder act in such a way that but few rays of light emerge from the apparatus directly; hence the liquid is suffused with a soft illumination which is admirably suited to the examination of the contents. This little apparatus, or a modification of it, is now being employed in various researches into the life processes of ferments and the culture of microbes, the illumination by the incandescent electric light being much more suitable for the study of these low forms of life than that from other artificial sources.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—XIX.

BY

Chas. Steinmetz.

WE are now able to discuss the polar diagram, Fig. 33, for constant secondary E. M. F., E_1. This figure shows an exceedingly flat diagram, so flat, that the phase of the primary impressed E. M. F. entirely disappears in the drawing, amounting only to .02°. This form of the diagram directly proves that this transformer has a very high efficiency even for light load, and will give almost perfectly constant secondary E. M. F. From the diagram, or calculations on the hand of the diagram, we get the values of the electric quantities of this transformer given in the table.

1. For full load, 7870 watts sec. output
2. " half " 3987 " " "
3. " $\frac{1}{10}$ " 78.08 " " "
4. " open circuit.

} for the primary impressed E. M. F., E_0 = 2723 volts max. value.

It is most remarkable that the efficiency even for $\frac{1}{10}$ load is still as high as 75 per cent., while the drop of potential at the secondary terminals, between full load and no load, amounts to only 2 volts effective = 2 per cent.

B.—Westinghouse High-Frequency 10-*Light Transformer.*

The small 1 h. p. Westinghouse transformer shows quite a different diagram. This was tested by Prof. Ryan at Cornell University, and the data, published in the "Transactions of the American Institute of Electrical Engineers," Jan., 1890, give the complete curves of instantaneous values for 1, full load, 10 lights; 2, half load, 5 lights; 3, $\frac{1}{10}$ load, 1 light; 4, open circuit.

Looking over the curves of instantaneous values we notice that the phase of the secondary E. M. F. lags behind the phase of primary E. M. F., and that this lag increases with increasing secondary current. If, however, there is no self-induction, that is, magnetic leakage, present, the secondary E. M. F. must be slightly in advance of the primary impressed E. M. F., as explained before. Hence the lag of secondary E. M. F. proves the existence of self-induction in the primary coil. At the same time, we see that the primary current, especially for open circuit, is very unlike a sine wave, so that this transformer will give us a good method of testing how near the assumption of sine-shape will come to the real facts, even in non-sinusoidal waves.

To find the phases and differences of phases in the fully loaded transformer, we make use of the definition of the cosine of the angle of difference of phase between two non-sinusoidal waves, given in chapter X., as the ratio of the mean product of instantaneous values, into the product of their effective means. Thus the difference of phase between primary impressed E. M. F., E_0, and secondary induced E. M. F., E_1, is given by

$$\cos \psi = \cos (E_1 E_0) = \frac{\text{mean } (e_1 e_0)}{\sqrt{\text{mean}^2 e_1 \times \text{mean}^2 e_0}}$$

and gives for full load the angle $\psi = -10.5°$, the phase of primary current, angle $\varphi = (E_1 C)$ is derived in the same way; angle $\varphi = 12.5°$, and the difference of phase between primary current and impressed E. M. F., angle $\omega = (E_0 C)$, angle $\omega = 23°$.

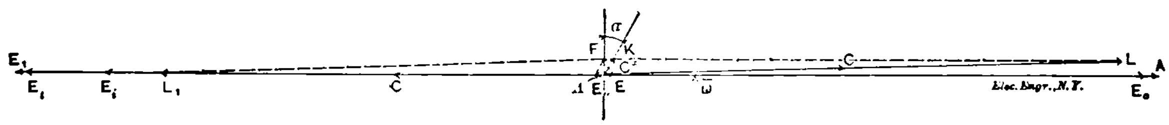


FIG. 33.

GANZ & CO. 10 H. P. TRANSFORMER.

Frequency, $N = 42.5$ complete periods per second. Primary impressed E. M. F., $E_0 = 2723$ volts maximum value.

	Angle of magnetic lag.	Phase of primary current.	Phase of impressed primary E. M. F.	Difference of phase between primary current and impressed E. M. F.	Secondary current.	Primary current, calculated from diagram.	Primary current, observed.	Difference between both, in per cent.	Secondary M. M. F.	Primary M. M. F.	Impressed M. M. F.	Resulting M. M. F.	Ideal M. M. F. of hysteresis.	Secondary induced E. M. F.	E. M. F. consumed by the secondary internal resistance.	Secondary terminal pressure, calculated from diagram.	Secondary terminal pressure, observed; difference between both, in per cent.	Primary induced E. M. F.	Primary resulting, or heating E. M. F.	Maximum intensity of magnetization.	Loss of energy. By hysteresis.	Loss of energy. In primary coil.	Loss of energy. In secondary coil.	Secondary output.	Efficiency, in per cent.
	α	ϕ	ψ	ω	amp. C_1	amp. C	amp. C	%	amp. turns L_1	amp turns L	amp. turns K	amp. turns F	A	volts E_1	volts E_{11}	volts E_t	volts E_t	volts E_i	volts E	lines per sq cent. H	watts	watts	watts	watts	
1. full load.	26°	2.05°	.02°	2.03°	166	6.00	6.05	1%	6360	6480	259	233	114	149.9	1.43	148.5	148.5-	2698	25	7130	194	76	76	7870	95.6
2. half load	26°	4.05°	.02°	4 03°	53.2	3.07			3195	3320	260	234	114	150.6	.71	149.9		2710	13	7160	196	20	19	3987	94.1
3. $\frac{1}{10}$ load..	26°	17.3°	.02°	17.3°	10.7	.73			640	790	261	235	115	151.1	.14	151.0		2720	3	7190	199	1.1	.8	78.08	75%
4. open sec.	26°	64°	.02°	64°		.24	.24			261	261	245	115	151.3		151.3		2723	1	7200	200	.12			

ELECTRICITY AND ADULTERATION.

AT the meeting of the Bavarian Society of Applied Chemistry, one of the speakers, Director Koehler, of Berlin, made a rather remarkable statement. He said that during a visit to the Strassburg Exhibition his attention had been attracted to the remarkably beautiful green color of some preserved beans, and upon inquiring as to how this color had been imparted he was told that it was a trade secret. Subsequently he had learned that during the boiling of these vegetables in a copper vessel an electric current was passed through the whole, the copper of the vessel acting as an anode, and that in this way a large quantity of copper was carried into solution, giving the vegetables a fine tint.

THE NEW 100 H. P. THOMSON-HOUSTON FREIGHT LOCOMOTIVE.

The continued success of electric street cars and the demands made by street railway companies for larger and more powerful motors to handle their cars has led others interested in transportation to investigate the advantages of electric locomotion, with the result that not a few electric tramways are in operation hauling freight about in cotton mills, iron works, mines, etc. In this department of work, also, there has been a constant demand for more powerful motors, so that where the electric locomotive formerly hauled a few bales of cotton it is now called upon to handle a fair-sized train. It was in compliance with a demand of this nature that the Thomson-Houston Motor Co., of Boston, some time ago undertook the construction of an

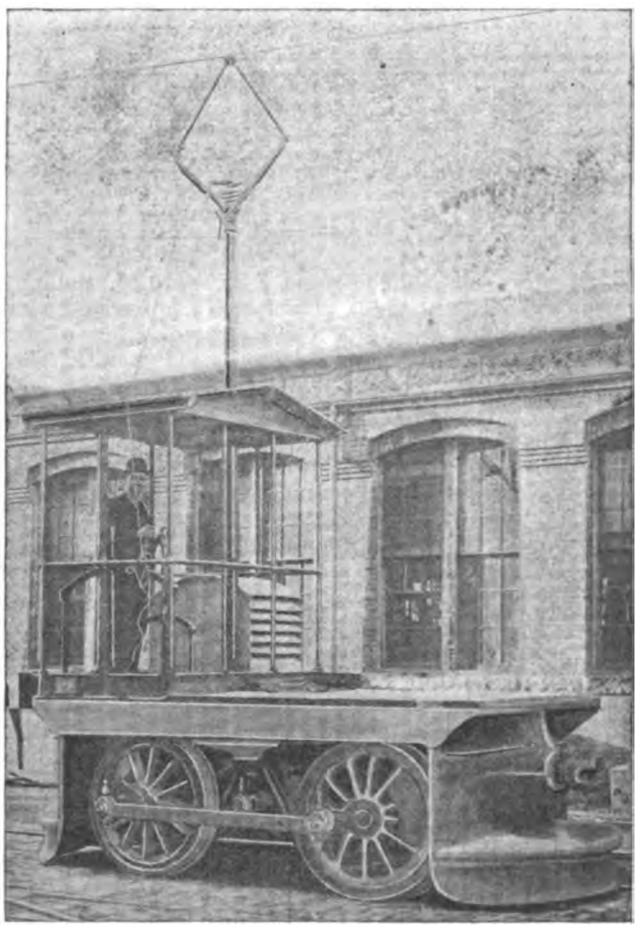


Fig. 2.—100 H. P. Thomson-Houston Freight Locomotive.

electric locomotive which is designed to obviate the necessity of employing a steam locomotive, and it may, indeed, be said to represent the first large freight locomotive displacing steam on a standard-gauge railroad. The Whitinsville Machine Co., of Whitinsville, Mass., for whom the locomotive was built, purpose to carry their merchandise back and forth from the railway station to their works, a distance of 1½ miles, by means of electric power.

At the invitation of the Thomson-Houston Motor Co., a large number of visitors assembled at the Lynn Works, on the afternoon of Saturday, Nov. 28, and witnessed the operation of the new motor.

The locomotive, which is illustrated in Figs. 1 and 2 of the accompanying engravings, is built in a square form with a platform for carrying loads, and cow-catchers and draw-bars at each end. The power is to be furnished by a large generator located at the works of the Whitin Machine Co., and conveyed over a trolley wire from which it is taken by means of a universal trolley bar attached to the locomotive.

The construction of the truck is well shown in the engraving, Fig. 3. The motor employed is one of the well-known "G" type of the Thomson-Houston Electric Co., and the power is communicated from the armature to the rear axle by means of double reduction-gearing, and from the rear axle to the forward one by means of parallel rods. The motor consists of wrought iron field magnets, which are bolted to magnetic yokes of mitis iron. One of these yokes carries the bearings which support that end of the motor on the axle, while the other yoke is spring supported from the other axle. This keeps the gears always in line, and meshing correctly with each other, and at the same time provides considerable spring support for the motor.

The gearing consists of aluminum bronze pinions and mitis iron gear wheels. This gearing runs in gear cases, in which a plentiful supply of grease is placed. This decreases the noise, friction and wear, and increases the life of the gears very materially. On the intermediate shaft is heavily keyed a mitis iron brake drum, which is covered with wood lagging. It is embraced by two half bands of steel, tightened upon it by means of the brake drum lever, situated in the operating stand.

The wheels are 42 inches in diameter and are heavily steel tired, and the frame consists of two heavy side plates in which are located the main axle bearings. Two heavy cast iron end plates in which are cast the cow-catchers are bolted to the side plates by means of heavy through bolts, which are a driving fit in reamed holes. These end plates carry the heavy spring draw-bars and bumpers.

The operating platform is located at one end of the main platform and is encased in a railing and covered with a protecting roof. On this platform are located the levers for operating the controlling mechanism, the brake and the double-acting sand boxes. The universal trolley bar also extends upwards from the locomotive at this point, as shown in Fig. 2.

The controlling mechanism consists of two large rheostats of the well known Thomson-Houston railway type. These are so arranged with their contact shoes that no reversing switch is needed. The operator stands so that he always faces in the direction in which the locomotive is to go, and being in this position, he pushes the rheostat lever from him to make the locomotive go forward, and pulls it towards him to make it go backward. A positive centre lock is provided, so that in turning the current off there is no danger of passing the neutral point on the rheostat, and so reversing the locomotive with the current on. When the operator stands in the above-mentioned position he pushes the brake lever from him in order to apply the brake. The bands are so arranged on the brake-drum that the friction tends to tighten them up more upon the wood lagging, and so assists the operator in braking the train.

The following data give the details of construction of the new locomotive, the construction of which has been under the direct supervision of Mr. J. P. B. Fiske, who is in charge of all the motor work of the company, except that relating to street railways and long-distance transmission:

Wheel base	6′ 4″
Diameter of wheels	42″
Speed reduction between armature and axle	1 to 25
Gauge	4′ 8½″ standard.
Wheel base	6′ 4″
Measured height above rail platform	4′ 4″
Greatest length of loco. (at cowcatcher)	15′ 9¼″
Greatest length of platform	12′ 7¼″
Greatest width of platform	7′ 1¼″
Weight of complete locomotive, less trolley pole	42,525 lbs.
Approximate weight of motor	5,400 lbs.

A combined main switch, lightning arrester and fuse-box is placed within easy reach of the motorman, so that he can instantly shut the current off from the locomotive by a slight movement of the hand.

The construction of the motor is of the most rigid and waterproof character, the field spools having their wire enclosed and entirely sewed up in canvas bags, which are covered with a heavy coating of waterproof paint.

The locomotive, which weighs 42,525 lbs., is designed to operate at 500 volts and to develop 100 h. p. at the draw-bar. This will enable it to pull a train of 4 to 6 heavily loaded cars, or an aggregate load of 200 to 300 tons, at a speed of 5 miles an hour on a level.

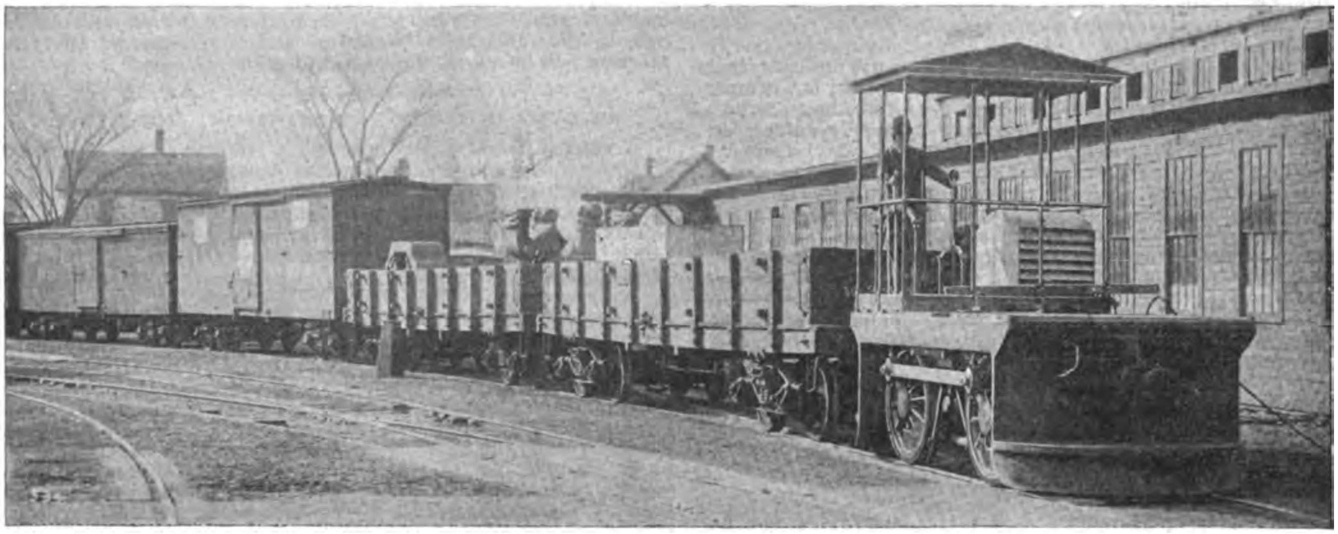


Fig. 2.—100 H. P. Thomson-Houston Standard Gauge Electric Freight Locomotive Drawing A Train.

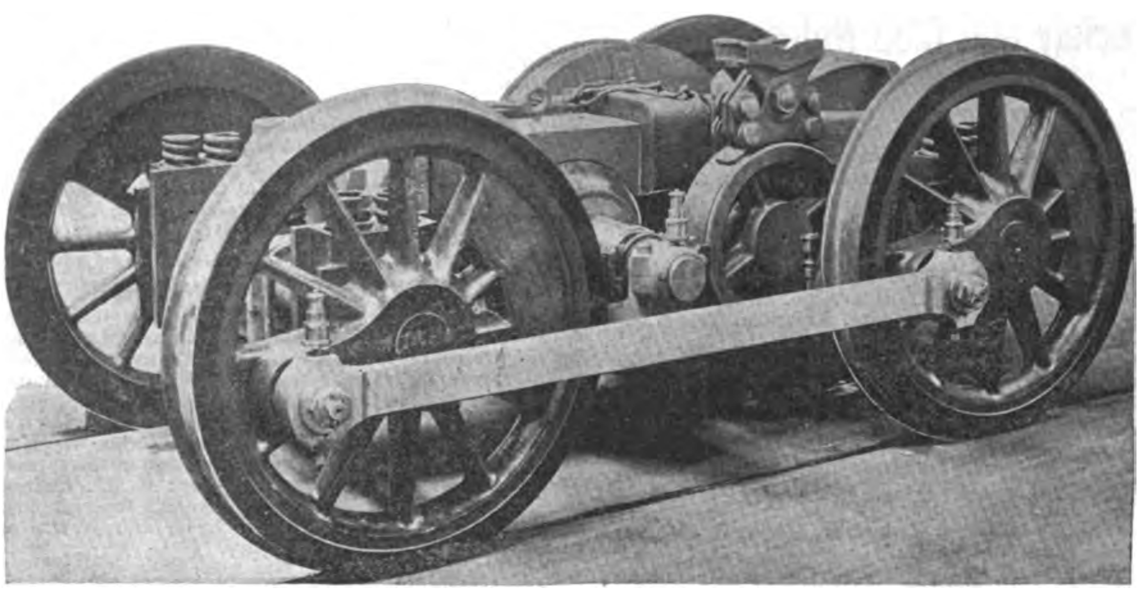


Fig. 3.—Truck of 100 H. P. Thomson-Houston Freight Locomotive.

THE ELECTRICAL PREPARATION OF CINNABAR.

Cinnabar is now being prepared by means of electrolysis, according to a French contemporary, from the metal, mercury, itself. The apparatus seems to be simple, and it is stated that the process is economical, while the product is of excellent quality. A vat, a metre in diameter and two metres in height, is the chief feature in the plant. On the sides of this vat are fixed two round metallic plates, each 15 centimetres in diameter. The mercury is placed in the vat, and the plates are connected up to the positive pole of a dynamo. At the bottom of the vat is a plate of copper covered with galvanized iron; this is connected to the negative pole of the machine. The vat is filled up with an aqueous solution of ammonium nitrate and sodium nitrate, and there is an ingenious device for supplying a constant and regular flow of sulphuric acid. The nitrate solution should contain

Ammonium nitrate...........	8 kilogrammes.
Sodium nitrate...............	8 "
Water......................	100 litres.

The liberated gas escapes by a tube in the cover of the vat, and in doing so keeps the liquid well mixed, and a precipitate of sulphide of mercury—cinnabar—falls to the bottom.

WATER POWER IN SWITZERLAND.

A scientist of Berne has been studying the subject of the water power that can be made available in Switzerland for the generation of electricity for light and power, and finds that 600,000 effective horse power can be obtained.

ECONOMY OF MULTIPLE EXPANSION ENGINES.

PROFESSOR ROBERT H. THURSTON contributes in the November issue of *Cassier's Magazine*, the new engineering monthly, a very interesting article on the "Philosophy of the Multiple-Cylinder Engine," in which he says the true action of the multiple-cylinder is now easily perceived. It is subject only to the wastes, apparently, of a single cylinder, of that one of the series which is itself most affected by wastes. The losses by internal condensation which would take place in a simple engine of equal total range of expansion, and working between the same extreme limits of temperature and pressure, which increase rapidly as that range is increased, are, in the multiple-cylinder engine, divided practically by the number of cylinders in series. This would indicate that the greater the number of such cylinders, the better; but it must be remembered that each new element thus introduced brings with it increased wastes externally, more friction, greater cost, and that these factors, in turn, limit the number of cylinders advisable, in the very best examples of high economy, to a very small number. Experience shows that it is, on the whole, not advisable to increase the number beyond about one to each four or five atmospheres pressure; or perhaps better, that the ratio of expansion should not exceed about three in any one cylinder, nor be less than two and a half. Thus it has been found by the best builders that the simple engine is best, as a rule, up to about 50 or 60 pounds per square inch, by gauge, the two-cylinder or double-expansion engine from that limit up to about 100 or 120, the triple-expansion up to 180 or 200, and the quadruple-expansion engine—four cylinders in series—beyond that point. Taking the limit of the expansion ratio at 8 and the terminal pressure at 10 pounds, and assuming hyperbolic expansion, we have the following as illustrating good practice, condensing engines being understood:

Engine	Ratio, Total.	Ratio, Single.	Limit of Pressure.
Single cylinder....	5	5	50 lbs.
" "	6	6	60 "
Double-expansion..	9	3	90 "
Triple-expansion...	27	3	270 "
Quadruple-expansion............	81	3	810 "
Quintuple-expansion...........	243	3	2,430 "

This would indicate that the four-cylinder engine is likely to answer all purposes up to quite as high a pressure as is ever to be expected to be used in the steam engine, so far as we can see, to-day.

Society and Club Notes.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

AT the council meeting of the American Institute of Electrical Engineers, November 24, the following gentlemen were admitted to associate membership:

F. W. Cushing, secretary, Central Electric Co., 118 Franklin street, Chicago, Ill.
S. W. Huff, manager, Electrical Department of Factory, Baxter Electric Motor Co., 2100 Druid Hill avenue, Baltimore, Md.
Angus S. Hibbard, general superintendent, American Telephone and Telegraph Co., 18 Cortlandt street, New York City.
Francis N. Sanborn, Manhattan Electric Lighting Co., 13 Spencer place, Brooklyn, N. Y.
Harold Babbitt Smith, Adj. Prof. in charge of Electrical Engineering Department, Arkansas State University, Fayetteville, Ark. Barre, Mass. (till Mar. 2).
James A. Vandergrift, assistant superintendent and electrician, Sawyer-Man Electric Co., 534 West Twenty-third street, New York City.
Elmer G. Willyoung, electrician, James W. Queen & Co., 924 Chestnut street, Philadelphia, Pa.
Charles H. Wilson, general superintendent, Chicago Telephone Co., 203 Washington street, Chicago, Ill.

The following associate members were transferred to full membership:

Herbert H. Eustis, president and electrician, Eastern Cable Co., 61 Hampshire street, Boston, Mass.
F. B. H. Paine, consulting electrical engineer, Chas. Paine & Sons, 71 Broadway, New York City.
George F. Curtiss, electrician, Thomson-Houston Electric Co., Lynn, Mass.
Edward C. Boynton, Elektron Manufacturing Co., Springfield, Mass.
H. W. Weller, railroad inspector, Edison General Electric Co., New York City.
P. B. Delany, inventor, South Orange, N. J.

MR. ROSEWATER AT THE ELECTRIC CLUB.

IT is now announced that the lecture on the Government Telegraphs of Europe by Mr. E. Rosewater, editor of *The Omaha Bee*, and president of the Old Time Telegraphers' Association, will be given at the Club on Thursday, December 3, at 8 P. M. The lecture will enter into a large number of details, and Mr. Rosewater's mission to Europe, as the special representative of Postmaster-General Wanamaker, has placed him in possession of a vast amount of most important and interesting information on the subject. Mr. Rosewater will have many of the original documents, forms, etc., with him. Several public men will participate in the subsequent discussion, and it is expected that the meeting will be one of the largest the club has seen.

MR. CARL HERING ON THE FRANKFORT EXHIBITION.

A VERY instructive and interesting lecture on the Frankfort Exhibition was delivered before the American Institute of Electrical Engineers, at the Electric Club, by Mr. Carl Hering, on Tuesday evening, November 24, before a large audience. The lecture was well illustrated by magic-lantern, and was heard with much pleasure by a large gathering of members of the Club and the Institute.

CHICAGO AMATEUR ELECTRICAL SOCIETY.

THE Chicago Amateur Electrical Society has decided to change its name to "The Chicago Society of Operative Electricians."

The objects of this society are the advancement of its members in the knowledge of electrical science by lectures to be given by prominent electricians interested in the society, and by a thorough course of study, using standard works under the supervision of an instructor. Mr. H. G. Brownell, a college graduate of several years' practical experience, has been chosen for this position. As soon as the finances of the society will permit, a library will be started, in connection with which a laboratory will be fitted up in order that theory may be demonstrated by practical experiment, a manner of study which has been adopted by our best colleges and manual training schools.

Another feature of the society will be an amateur electrical display at the World's Fair. Mr. J. Allen Hornsby, secretary of the Electrical Department of the Columbian Exposition, in an address to the society, stated that the department would endeavor to secure for it the same honors given the professionals in all departments which could possibly come in its sphere. He also promised that heat, light, and power would be furnished for the exhibit. A committee has been appointed to make arrangements for an exhibition, and is already hard at work. Considerable interest in the society is being manifested by young men interested in electrical work and a large membership will soon be had. The regular meetings are held on the first and third Thursdays of each month. On Monday evenings the members come together for informal study and discussions.

It is earnestly requested that all young men interested in the study of electricity will take an interest in the work of the society, and that similar societies and experimental clubs will correspond and co-operate with this society in its endeavor to secure a creditable amateur electrical display at the World's Fair.

All communications should be addressed to the corresponding secretary, S. G. Arnold, room 5, 120 Quincy street, Chicago.

THE CRANFORD TELEGRAPH ASSOCIATION.

THIS association, of Cranford, N. J., has a membership of 13, who have formed themselves into a fire and police department for the protection of the town. Monthly meetings are held, and a knowledge of the practice and principles of commercial and railway telegraph is required. All members are pledged to turn out on general alarms. The individual members own all instruments, while the association owns the batteries, wires, etc., which are in the charge and under the supervision of the superintendent. The officers are E. K. Adams, president; F. E. Friedrichs, secretary and treasurer; W. B. Rosencranz, superintendent. The example set by this association might be followed with advantage in many another small community.

Appointments, Etc.

MR. L. K. PEROT, late of the Thomson-Houston Electric Co., has been appointed assistant engineer of the Equitable Engineering & Construction Co.

MR. J. H. REEVES, late superintendent of the Huntington Reformatory electric light plant, has been placed in charge of the station of the Home Electric Light Co., Tyrone, Pa.

MR. HARRY W. HAMBLIN, ex-manager of the Pawtucket Electric Light Co., of R. I., and Consolidated Electric Light Co., of Portland, Me., has connected himself with H. W. Leonard & Co., Electrical Exchange Building, New York City.

College Notes.

UNIVERSITY OF MINNESOTA.

THE Department of Electrical Engineering of the University of Minnesota has bought a nine-light Thomson-Houston arc machine, with a number of lamps of different makes. It has already received two Edison motors, which are in use, with a 10-kilowatt Edison generator. A 300-light alternator is to be ordered immediately, and other additions are in prospect. The number of students at the University this year is the largest in its history, and is continually increasing.

TULANE UNIVERSITY OF LOUISIANA.

TULANE UNIVERSITY, New Orleans, has recently added to its electrical equipment 12 dynamos, 14 arc lamps, and a variety of meters, instruments and accessories. Among the additions are three arc systems, a Thomson-Houston 6 light, an Edison 5 light, and a Wood 15 light. There is a 300 light Slattery alternator with converters, instruments, etc., and four Edison motors of different styles and sizes. The course is very popular, and has an increased number of students this session.

Reports of Companies.

THOMSON-HOUSTON ELECTRIC CO.

IT was b lieved at the beginning of the year, says the Boston *Transcript*, that the Thomson-Houston Electric Company would earn this present fiscal year from $2,000,000 to $2,500,000 net or not far from $4,000,000 above all dividend requirements. Of course it was not expected that the phenomenal earnings of $3,000,000 net made last year were to be repeated this year but the Boston News Bureau says that it now looks as if $2,500,000 net might be reached the present fiscal year, ending Feb. 1, 1892, or more than $1,000,000 surplus over the $1,240,000 required for dividends upon the present basis. There is, therefore, says the Bureau, good basis in earnings for expectation by Thomson-Houston stockholders of something more than $4 per share from present earnings. Below is a comparative statement of the business of the Thomson-Houston Company for the three months ended Oct. 31, 1891 and 1890, and for the nine months ended the same dates in both years. The profits shown, however, are for the Boston office only.

Quarter :—	18891.	1890.	Increase.
Gross sales............	$3,098,573	$2,785,073	$313,500
All exp. and com's......	2,273,408	2,078,896	194,522
Net profit...	$825,165	$706,187	$118,978
9 months ended Oct. 31—			Decrease,
Gross sales............	$7,163,411	$7,514,520	$439,109
All exp. and com's....	5,600,628	5,788,421	287,806
Net profit...	$1,562,783	$1,626,069	$63,309

STANLEY ELECTRIC MANUFACTURING CO.

AT the annual meeting of the Stanley Electric Manufacturing Company, practically the old board of directors were chosen. They then re-elected the old board of officers. Manufacturing has been going on the past six months, and the result has been most gratifying to the shareholders.

Legal Notes.

BRUSH CO. vs. WESTERN ELECTRIC CO.—ARC LAMP INFRINGEMENT.

SUIT to restrain the Western Electric Company, of Chicago, from manufacturing and selling electric arc lamps has been begun in the United States Circuit Court at Chicago by the Brush Electric Light Company, of Cleveland. The defendant company, it is alleged, is now manufacturing and selling a large number of the lamps similar in construction to those covered by the Brush patent. An injunction, with accounting, is asked for.

ENGINE FOR THE WORLD'S FAIR.

THE Bureau of Construction of the Worlds' Columbian Exposition have contracted for a 400 h. p. Armington and Sims' engine for use in connection with their temporary light and power plant. The engine was shipped immediately, and is probably in operation by this time. The matter is in the hands of the Pond Engineering Company, general Western agents for the Armington and Sims engine.

Patent Notes.

A BROAD PATENT ON POWER TRANSMISSION GRANTED TO H. W. LEONARD.

A VERY full description was given in THE ELECTRICAL ENGINEER last week of the new and ingenious method of motor regulation invented and employed by Mr. H. Ward Leonard. A very broad patent has now been granted to that well-known engineer, No. 463,802, dated November 24, 1891, with 26 claims. To show its scope it will suffice to quote a few of the claims;

1. The method of operating and regulating an electric motor, consisting in maintaining the strength of its field-magnet and the position of its commutator-brushes constant and altering its speed by varying the electromotive force supplied to its armature, substantially as set forth.

5. The method of performing work by the use of electric energy, which consists in varying the electromotive force in proportion to the "foot" element of the foot-pounds per second of the power required and varying the current in proportion to the "pounds" element, substantially as set forth.

8. The combination of an electro-dynamic motor, a source of supply for its armature, a separate constant source of supply for its field-magnet, and means for varying the potential of the armature-supplying source, located at the point of work performed, substantially as set forth.

12. The combination, with a wheeled vehicle, of an electric motor mounted thereon to propel the same, said motor having its armature and field-magnet energized by separate circuits, and means on the vehicle for varying the electromotive force of the energy supplied to the armature of said motor, substantially as set forth.

24. The combination of a source of alternating current of high tension, means for converting such current into a continuous current of lower tension, and a motor having its armature supplied by such continuous current and its field-magnet separately excited, substantially as set forth.

26 The method of transforming the energy of a prime motor at any speed nto propelling energy at any desired speed, which consists in operating an electrical generator by said prime motor, supplying the armature of an electric motor running in a constant field from said generator, and varying the electromotive force of said generator to vary the speed of said electric motor, substantially as set forth.

A NEW GALVANIZING PROCESS.[1]

A NEW process for protecting iron and steel is being introduced into England by Messrs. Joseph Westwood & Co., Napier Yard, Millwall, London, E. The metal to be coated is passed through an acid pickling bath, then through an alkaline bath to remove acid, treated with a flux of zinc chloride and stannous chloride, and when thus prepared covered with metallic lead by immersion in a bath of that metal. The point of novelty in the process appears to be the attainment of a close adherence of the lead to the iron by scrupulous attention to cleanliness and the use of specially devised fluxes. The preliminary pickling is accomplished by the passage of a week current of electricity through the bath in which it is conducted, and on this somewhat slender ground the method has been termed an "electro" lead process. It will be seen that the *modus operandi* and the result attained bear striking resemblance to those of the process of the London Metallurgical Company.

As far as can be judged from the statements that have been made public, the chief difference consists in the use by the latter of a lead alloy and by the former of pure lead. However, this may be the products of the two processes are much alike in appearance, and presumably in properties.

As far as could be seen from tests made of the material at Messrs. Westwood & Co.'s works, the adhesion of the lead coating was remarkably perfect. Sheet iron thus protected was bent double without causing the appearance of any tendency to crack or exfoliate, and specimens of bar were shown which had been twisted spirally upon themselves and were similiarly perfect. Sheet metal can also be flanged or corrugated without the coating suffering injury, and the method is also said to be applicable to wire in an equal degree. Wire netting is susceptible of treatment by this method, and the coating it receives is distinctly better in appearance than that produced by galvanizing. The non-tendency of the coating to separate from the metal it is designed to protect is one of the advantages claimed, another of importance being the retention of its tensile strength by the iron or the steel coated, contrasting favorably in this respect with the effect produced by zinc. Indeed, it is claimed that in some cases the strength of the material is enhanced by the coating process, the good effect upon hard steel wire being specially noticeable.

There remains, however, some hope for the galvanizing trade proper. Although lead is much less corrodible than zinc by most of the destructive agents to which coated articles are exposed, yet it by no means follows that the powers of resistance of the articles protected stand in the same order. It is needless to elaborate upon this point; a short consideration of the electro-chemical relations of iron, lead, and zinc will suffice to show wherein the weakness of the new method lies. Zinc is a brittle metal, and one little adapted for a protective coating, but its chemical properties make it the best metallic preservative for iron known, and it will be pushed from its pre-eminence with great difficulty. At the same time there are numerous applications open to lead-covering processes such as that we have described.

1. *Industries.*

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED NOVEMBER 24, 1891.

Accumulators :—

Separator for the Plates of Secondary Batteries, C. F. Waldron, 463,879. Filed Jan. 19, 1891.
Separators are in the form of wooden pockets or folds, each inclosing one of the plates of each pair.

Clocks :—

Electric Programme-Clock, J. L. McCaskey, 463,848. Filed May 12, 1890.

Conductors, Conduits and Insulators :—

Wire-Hanger, C. A. Jacobs, 463,756. Filed Feb. 14, 1891.

Machine for Covering Conductors, C. Klotzbach, 463,809. Filed Aug. 1, 1891.

Machine for Covering Conductors, C. Klotzbach, 463,810. Filed Aug. 1, 1891.

Electric-Wire Insulator, H. F. Newell, 463,955. Filed Feb. 28, 1891.

Dynamos and Motors :—

Brush-Holder for Electric Motors, J. E. Lyons, 463,635. Filed Mar. 19, 1891.

Electric-Motor Mechanism, S. E. Mower, 463,639. Filed June 16, 1891.
Relates to speed-reducing devices, and is specially applicable to railway motors.

Armature-Core for Dynamo-Electric Machines, E. Thomson, 463,671. Filed Aug. 5, 1889.
The core is built up from plates of sheet iron having a thin scale or coating of hard insulating substance formed naturally in the process of manufacturing sheet iron, and thin interposed distinct separating plates of non-magnetic metal.

Electric Motor and Generator, I. E. Storey, 463,693. Filed Apr. 16, 1889.
A novel construction of a shunt-wound machine.

Commutator for Electrical Machines, W. W. Vail, 463,694. Filed June 23, 1890.
A pole-changer, for shifting from a continuous to an alternating current.

Electric Motor and Dynamo, A. L. Parcelle, 463,704. Filed Apr 2, 1891.
A ring armature machine. Relates especially to details of construction.

Carbon-Brush Clamp for Dynamos, S. Morse, 463,748. Filed July 25, 1891.

Electrical Transmission of Power, H. W. Leonard, 463,802. Filed Aug, 14, 1891.
Claim 1 follows:
The method of operating and regulating an electric motor, consisting in maintaining the strength of its field-magnet and the position of its commutator-brushes constant and altering its speed by varying the electromotive force supplied to its armature. See "Patent Notes," page 613.

Lamps and Appurtenances :—

Electric-Arc Lamp, W. S. Hays, 463,720. Filed July 27, 1891.
Relates to mechanical construction.

Lamp Socket, E. Voigt, 463,763. Filed Nov. 18, 1890.

Means for Suspending Electric Lamps, T. H. Brady, 463,778. Filed Feb. 18, 1891.

System of Electric Lighting, E. J. Hodgson & J. W. Stearns, Jr., 463,793. Filed Feb. 26, 1891.
Employs a cut-out located in proximity to the lock of a door and adapted to be operated by the mechanism of the lock, whereby lamps may be lighted or extinguished upon entering or leaving a room.

Measurement :—

Electric Meter, A. Reckenzaun, 463,711. Filed Nov. 1, 1890.
Claim 1 follows:
An apparatus for measuring electric currents or the product of time and currents, comprising indicating mechanism, electromagnets, gravitating means intermediate of said magnets and indicating mechanism and acting by gravity to move said indicating mechanism, and a member periodically making circuit with said magnets in alternation for energizing them to lift said gravitating means.

Medical and Surgical :—

Electrical Surgical Instrument, F. L. Connable & T. V. Harper, 463,785. Filed Jan. 15, 1891.

Therapeutic Electric Battery, J. A. Crisp, 463,945. Filed Mar. 31, 1891.

Miscellaneous :—

Electric Controller for Elevators, W. Baxter, Jr., 463,615. Filed Jan. 29, 1891.
Employs an electromagnetic shifter for operating the coupling between the motor shaft and the hoisting pulley.

Electric Cigar Lighter, G. N. Engert, 463,754. Filed Dec. 24, 1890.

Electric Arc Interrupter, E. Thomson, 463,762. Filed Dec. 15, 1890.
Claim 1 follows:
The combination, with an electric circuit-breaker, of an arc distorter acting to drive the arc out of position, and a bundle of insulated conducting plates for receiving and extinguishing any arc formed at the circuit breaker.

Multiple Fuse Cut-Out, G. K. Wheeler, 463,764. Filed Nov. 26, 1890.

Electric Cut-Out, E. W. Rice, Jr., 463,770. Filed Dec. 2, 1890.

Electric Subway Switch, L. A. Fehr, 463,808. Filed Nov. 28, 1890.

Automatic Safety Cut-Out for Electrical Conductors, R. A. Morgan, Jr., and G. C. Bosson, Jr., 463,867. Filed Nov. 28, 1890.

Phonograph, H. T. Holtz, 463,989. Filed April 23, 1891.

Starting and Stopping Device for Phonographs, H. T. Holtz, 463,990. Filed July 11, 1891.

Railways and Appliances :—

Railway Signal, E. J. Samuels and F. E. Behrendt, 463,691. Filed May 14, 1891.
Relates to the operation of train order signals from a telegraph office and at some distance.

Conductor and Guide for Electric Railway Trolleys, J. I. Conklin, 463,715. Filed Feb. 10, 1891.

Self-Lubricating Trolley Wheel, W. Duncan, 463,733. Filed Sept. 24, 1890.

Electric Conductor for Railways, C. E. Sargent, 463,760. Filed July 10 1891.
Conductor is U-shaped in cross-section and has insulation on the outside; it is mounted with the open side downwards, the trolley making contact on the inside.

Section Insulator and Lightning Arrester, for Electric Railroads, E. Thomson, 463,761. Filed Sept. 1, 1890.
Comprises separate conducting plates secured in place, but spaced apart and insulated at points somewhat above their contact surfaces and having such contact surfaces separated entirely from each other by an air insulation space, but rounded and arranged in line to form a continuation of the path of travel of the contact device.

Trolley for Electric Railways, G. H. Alton, 463,765. Filed Feb. 16, 1891.

Switch for Electric Railways, F. O. Blackwell, 463,766. Filed Jan. 26, 1891.

Trolley Wire Hanger, E. T. Birdsall and L. W. Serrell, 463,894. Filed Dec. 1, 1890.

Telegraphs:

Synchronous Telegraph, C. S. Bradley, 463,852. Filed Jan. 28, 1887.
Claim 1 follows:
In a telegraphic system, the combination of two alternating current machines located at different points, mutually reacting to maintain continuous synchronous movement, an electric connection between them, and telegraphic transmitters and receivers located at such points, the connecting circuit of which passes through synchronously driven mechanism controlled by said alternating machines.

AN ELECTRIC RAILROAD OF 149 MILES.

OF the proposed electric railroad between Budapest and Vienna, further details are given in a late number of the *Verkehrs Zeitung*. According to these, there will be for the 149 miles of road two main power stations with 100 substations, and only three or four stopping places. The cars will be 131 feet long, and will be fitted with four two-axle bogie trucks. At each end of a car there will be two large electric motors, to which the current will be transmitted by contact wheels running on conductor rails. The speed which it is proposed to attain in regular working is 200 kilometres (124.2 miles) per hour, and in order to diminish the air resistance the ends of the cars will be shaped like ships' bows. The distance between Vienna and Budapest is to be covered in 75 minutes, and cars are to be run at quarter-hour intervals. Up to the present, permission to build the road has not been granted by the authorities, but there is thought to be little doubt that the line will be taken in hand in the near future.

ELECTRICAL ENGINEERING PUPILS IN ENGLAND.

A CASE, which must be significant both to teachers of electrical engineering and to pupils, has been heard in the English law courts, writes our London correspondent. Mrs. Uniacke claimed, against Mr. Ronald Scott, a well-advertised teacher of electrical engineering, the repayment of a premium of £150 paid for the apprenticeship of her son to the defendant. The action was based on an alleged breach of deed. It was proved that Mr. Ronald Scott had failed, during a nine months' apprenticeship, to teach to his apprentice anything which would be useful to an electrical engineer. The boy, Uniacke, had been kept to the work of filing and fitting brass rods; he had also, for some slight inattention, been sent away from the works. Mr. Justice Romer made strong comments on the conduct of the defendant and finally gave a judgment in favor of the plaintiff with damages. It was stated in the evidence that Mr. Scott had 65 apprentices in his workshops, and only 7 workmen, including manager and foreman.

THE CENTRAL ELECTRIC CO.

THE Central Electric Company report a large increase in their lamp business since they have taken the agency for the Swan lamp. The 16 candle-power lamp of the Swan make has an efficiency of between 3.3 and 3.4 watts per c. p. and an average life of from 600 to 1,000 hours, and does not blacken even when nearly burned out. The company claims that the demand is for high efficiency and good average life rather than low efficiency and extra long life. The company have issued a circular giving low prices on a number of standard supply articles. This circular covers sockets, switches, cut-outs, receptacles, attachment plugs, branch blocks, wire guards, tape, shades, lamps, etc. They have just taken the agency for the Washington carbon and will carry a large stock. These carbons are designed for both high and low-tension systems. They are claimed to give long life and are perfectly straight and uniform.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The object of advertising is to keep in touch with old customers and to secure new ones.

THE "C. S." COMBINATION REFLECTOR LAMP SHADE AND HOLDER AND PORTABLE LAMP STAND.

THIS lamp shade, which is about to be put upon the market by the Cutter Electrical and Manufacturing Company, 27 South Eleventh street, Philadelphia, presents some unique claims to favor. It will carry any size or style of lamp, and is provided with its own shade-holder which is adapted to automatically fit any and all systems. It permits the renewal of an exhausted lamp with the least expenditure of time and trouble. It directs the light exactly where it is wanted and to no other point. It is made of aluminum and glass, weighs less than five ounces, and may be "knocked down" and "nested" for shipment. It has but one destructible part—the glass diffusion plate—which if accidentally broken is easily replaced at a trifling cost.

Briefly, this reflecting shade may be described as a combination of a parabolic with a plane radiating reflector to which is attached a diffusion plate of ground glass, and the arrangement of these different parts is such as to direct the main portion of the rays of light into a given zone of illumination, while a minor portion is radiated and diffused throughout the room. The diffusion plate is fixed securely to the radiating portion of the shade by means of a simple interlocking device, which admits of an easy separation of the two parts when it is necessary to remove or replace a lamp. At the apex of the parabolic reflector is an aperture sufficient only for the passage of the stem or shank of the lamp, and upon the rim of this aperture is affixed the automatic shade-holder, which is a novel arrangement of three spiral springs

THE "C. S." COMBINATION REFLECTOR, LAMP SHADE AND HOLDER.

that close in upon the shoulder formed by the junction of the bulb with its brass mounting when the stem of the lamp is passed through it; thus, the top of the shade fits closely around the stem of the lamp, shutting off all vertical rays, the general result being a strong white light immediately in front of the shade, and a gentle diffused light throughout the room, there being no marked boundary to the zone of illumination.

The portable lamp stand consists of an upright metal tube mounted upon an ornamental base of spun metal and marble. From the upper end of this standard projects a hollow flexible arm to the end of which is affixed the ordinary lamp socket.

This flexible arm is so arranged that it may be bent in any direction or coiled upon itself if desired, and in whatever position it be placed it remains. The stand is wired by means of a fireproof flexible cord, which, entering the fixture through an ebonite sleeve placed in the ornamental base, passes up through the standard and the flexible arm to the lamp socket. The interior construction of the flexible arm is such as to protect the conducting cord from being crushed or abraded, however the arm may be coiled or bent, and is practically indestructible.

This flexibility of the arm enables the user not only to concentrate his light upon any desired point at will, but permits him in so doing to form the arm into almost any graceful curve that may be suggested. This flexible arm may also be used as a wall bracket.

THE "DICK & CHURCH" TANDEM COMPOUND ENGINE.

The following notice has been issued by the Phœnix Iron Works Co., of Meadville, Pa.

To all whom it may concern:

It lately having come to our notice that some builders of Tandem compound engines are copying our construction and design, we deem it no more than proper to give notice that this improved construction was patented November 18, 1890, and is the exclusive property of this company, and that we shall protect our rights as against all builders or users of engines.

The 'Dick & Church" Tandem compound engine, as built by us was illustrated in this journal in the issue of September 30, 1891, in which was shown cuts of the engine together with a full description of same. The advantages of this construction, as against any other known design, are manifest, and others, as well as ourselves, evidently recognize it, but we trust this will be sufficient to prevent any further acts of piracy; at all events we hav endeavored to protect the general public by publishing this notice. It is our good fortune to own this design for tandem construction, and we suggest that other builders who recognize its important advantages should at least have the courtesy to write us before making use of it, no matter whether they propose to use an exact reproduction or merely copy as near as they think will be safe and evade our claims. We should like them to at least do us the honor of letting us have the credit of possessing the merit of originality.

H. WARD LEONARD & CO.

LARGE manufacturing companies are quick to appreciate the advantages of having in their employ experienced and neutral electrical engineers to advise them as to applications of electricity in their business. This is evidenced by the success in this line which H. Ward Leonard & Co. are obtaining. Among the concerns of importance who have recently retained them as consulting electrical engineers are Wm. Sellers & Co., the well-known machine tool builders of Philadelphia; Otis Brothers & Co., of elevator fame, and the Ingersoll-Sergeant Drill Co. No large manufacturing concern whose product involves the use of power can afford to neglect the rapid progress of electrical motor applications.

H. Ward Leonard & Co. charge a definite sum per year for their services as consulting engineers, and the manufacturing concerns seem to like this feature of definiteness rather than a percentage or a retainer and individual charge for individual service.

H. W. BURNET.

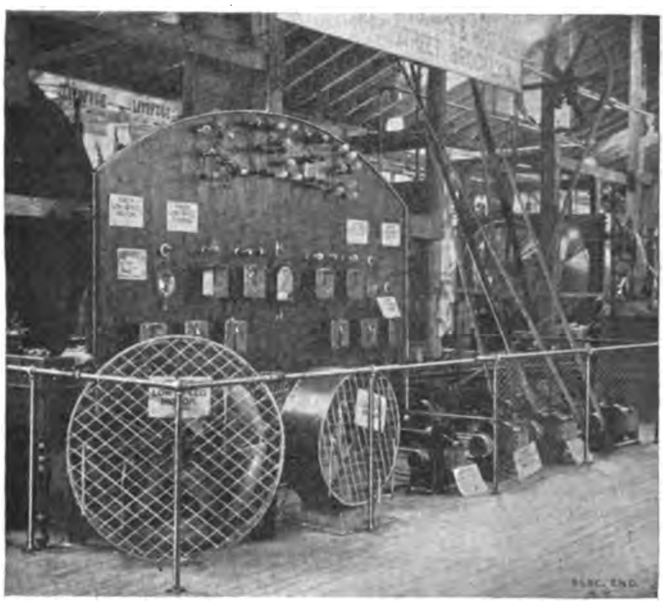
ON another page will be seen an article by Mr. H. W. Burnet, electrical engineer, of 12 North Grove street, East Orange, N. J., describing the new rosette and switch designed by him. Mr. Burnet also manufactures dynamos, motors, electrical instruments, experimental apparatus, etc., and has recently made several push-button sockets for the various standard lamps, which are said to be perfect in action, simple in construction and low in price, and have the additional advantage of being operated with one hand where the lamp is suspended or on a shaky fixture.

THE ELECTRIC MERCHANDISE CO.

ON account of a steady increase of business, the Electric Merchandise Co., of Chicago, have been obliged to lease the upper part of their building and will remove their offices to the second floor, thus giving them needed room for stock and also enabling them to handle their shipping in better shape. The company deserve all the success which has come to them. The decision of General Manager Mason to confine the business of the company to "electric railway supplies only" was a wise one and has resulted in the company's being recognized as headquarters for such supplies.

THE RIKER EXHIBIT AT THE AMERICAN INSTITUE FAIR.

ONE of the finest electric motor exhibits at the fair for many years is that of the Riker Electric Motor Co. On the extreme right can be seen three 50 light generators, each covering 29 inches by 10 inches, running at the low speed of 850 revolutions per minute. Next is a 3 h. p. 220 volt motor running at 750 revolutions, driving a 25 light dynamo. Then a 2 h. p. motor of 770 revolutions belted to a 15 light dynamo running at 830 revolutions. Also a 1 h. p. motor speeded to 800, driving an 8 light dynamo at 870 revolutions. Near the main aisle may be seen their low-speed motors directly connected to the Huyett & Smith and the Blackman ventilating fans. One of the prominent features of the exhibit is their switchboard on which are arranged the numerous regulating and controlling devices for the machines above mentioned, including their fireproof, slate-topped dynamos, regulators and motor boxes, and their new 2-speed fan switch.



RIKER EXHIBIT AT THE AMERICAN INSTITUTE FAIR.

In the centre of the board will be seen a Walker ammeter so attached to the three fifty light dynamos that the current of any separate generator can be read at any time without opening or disturbing the circuits of either of the two remaining generators. The dynamos are all compound wound to rise 2 per cent. under full load, and the armature and fields are so balanced that when the load is changed from full to light there is no sparking. The laminated field answers so readily to the change of load that when all but one lamp is thrown out of circuit there is no perceptible difference in the pressure on the circuit. The same close regulation will also be found in the motors, not only incandescent, but arc.

The arrangement and installation of this exhibit reflects great credit upon the assistant electrician, Mr. Churchward.

ELECTRIC APPLIANCE COMPANY.

THE Electric Appliance Co. report having secured the general Western agency for the swinging ball lightning arrester and Walker ammeter. The Swinging Ball lightning arrester has successfully stood the test of the past two years. Testimonial letters from every user tell the story, and the manufacfurers have yet to record a single instance where it has failed to do its work. The swinging ball lightning arrester has no fuse and needs little or no attention. It is entirely protected from moisture, and has no electromagnet or intricate parts to adjust. Each arrester is provided with a terminal wire to be joined to the line, and a binding post for the ground connection. They are adapted for either arc, incandescent or street railway circuits. Where converters are in use it is desirable that one be placed between each converter, and on straight incandescent circuits on the outside of the building or pole where the circuit enters; the idea being not to allow the lightning to enter the station at all, but to carry it to ground at different points along the line. From the results claimed it would appear that the swinging ball solves the long-unsettled lightning-arrester problem. The Walker ammeter is too well known to need comment, and fills the demand for a reliable instrument at a moderate cost.

SILICON BRONZE SPAN WIRE FOR ELECTRIC ROADS.

MR. F. STONE, of the Aluminum Brass & Bronze Co., 53 Chambers street, N. Y., reports a most gratifying increase in the demand for their new No. 2, silicon bronze span wire, of which Mr. G. W. Mansfield spoke so highly at the Pittsburgh Street Railway Convention, as the result of hard, practical experience. His figures were:

	Diameter.	Breaking Weight.	Breaking Weight per sq. in.	Elongation in six feet.	Twists in six inches.
No. 1, Silicon Bronze,..	.200	2,550	81,800	.8 per ct.	37.4
Galvanized Iron,......	.205	1,730	52,000	7.8 "	19

The following is also of interest, being a comparative table showing size of galvanized iron and copper wire to give the same strength as silicon bronze wire:

	Dia.	Breaking Wgt.	Per sq. in.	Wgt. per mile.
Silicon Bronze......	.200	2,550 lbs.	81,800 lbs.	639 lbs.
Gal. Iron...........	.250	2,550 "	52,000 "	874 "
Copper W....	.310	2,550 "	35,850 "	1,538 "

A wire that shows such an extraordinary combiniation of desirable qualities is likely to become the first and only choice of those who want good and lasting line construction.

RECENT WESTINGHOUSE SALES.

THE Philadelphia office of the Westinghouse Electric and Manufacturing Co., C. A. Bragg, manager, reports the following recent sales: Columbia Electric Light Co., Phila., one 3,000 light alternating current dynamo; Faraday Heat, Power and Light Co., Morton, Pa., one 750 light alternating current dynamo; Merchants' Electric Light Co., of N. Front street, Phila., one 1,500 light alternating current dynamo; Pennsylvania Steel Co., Sparrows Point, Md., one 60 light alternating current arc dynamo; E. & G. Brooks Iron Co., Birdsboro, Pa., 225 light plant, U. S. direct current system; Alexander Bros., Phila., 100 light plant, U. S. system; Onderdonk Heating and Ventilating Co., Phila., 50 light plant, U. S. system; Aldine Hotel, Phila., 1,000 light plant, U. S. system; Boothby's Restaurant, Phila., 800 light plant, U. S. system; G. and H Barnett, Phila., 300 light, increase, U, S. system.

THOMSON-HOUSTON CARBON CO.

THE factory of the Thomson Houston Carbon Co., at Tremont, O., was destroyed by fire on November 24, with a loss of $200,000; insurance, $120,000. A special dispatch from the company to THE ELECTRICAL ENGINEER says: "While we had a bad fire last evening, our stock-room was saved, with many millions of carbons. We shall be able to supply all our customers and others promptly, and shall rebuild at once."

ELECTRIX CHINA SWITCH.

THE accompanying illustration shows a new china decorated switch introduced by the Star Electrix Co., of Philadelphia. This switch is made entirely of china, cover and all, and is extremely

ELECTRIX CHINA SWITCH.

popular already among architects and others who have seen it, as it is the only article in the market that meets the requirements of an artistic taste, in connection with installations in residences, clubs and hotels where the finest finish is required. These switches are made in plain ivory, jet, and all tints, and variously decorated.

THE AKRON ELECTRICAL MFG. CO.

THE Akron, O., Electrical Mfg. Co. are pushed to the utmost in their new works in turning out their new style slow-speed automatic motors and dynamos. They have just installed motors of 500 volts potential in the following places: Schumacher & Gammeter, coffee roasters, etc., 3 h. p.; the Seaman Mfg. Co, saddlery and harness works, 5 h. p.; Capron & Curtiss printing house, 8 h. p.; Akron Engraving and Printing Co., 8 h. p.; the Geo. Jackson Printing Co., 2 h. p.; the Cohn Awning Company, 8 h.p.; C. H. Allen, printer, 1½ h. p.; N. Laskaris & Co., confectioners, 2½ h. p.; Yeomans & Co., confectioners, 1½ h. p.; City of Akron Municipa lBuilding, 100 lights, the Webster Camp & Lane Machine Company, eight 1,200 c. p. arc light dynamo, all in Akron, Ohio; one 1 h. p. motor in Warner's harness works at Zanesville, Ohio, and have numerous orders on their books for more machines, which they are pushing through their works. They are making a specialty of small incandescent lighting plants with very successful results. Their slow-speed machines, while costing more money to manufacture, are being sold at popular prices and are giving excellent satisfaction. All of their work is guaranteed, and their fire-alarm apparatus is being installed in a number of the smaller cities throughout the West, and is reported upon as very satisfactory.

THE NEW "SECURITY" INSULATOR.

THE accompanying illustration shows a novel form of insulator about to be introduced by the Security Insulator Co., of 136 Liberty street. As will be readily understood, the wire is easily and quickly adjusted, and is securely held in position without injury to the insulation. The wire is pressed into the groove and

THE "SECURITY" INSULATOR.

held by the cap, while a cam movement allows different sizes of wire to be held equally well.

This insulator entirely obviates the necessity of tie wires, thus effecting a great saving of both time and labor in wiring. The insulator here illustrated, which is full size, will take wire ranging from ⅛ to ⅝ inch. Other sizes are made to suit various requirements. They are made of the best vitrified and non-absorbent porcelain, and are as durable as they are simple and effective.

THE ASTORIA ELECTRIC MANUFACTURING CO.

THE above company has been incorporated for the manufacture of motors for street railways, whether operated by the trolley, accumulator, or conduit systems, and also for stationary work. The shops will be situated at Steinway, L. I.

The company will be under the general managership of Mr. Wm. M. McDougall, whose patents on electric railway devices have been acquired by the company, and Mr. Townsend Wolcott will have immediate charge of the electrical work.

Within a short time it is proposed to have a storage car in operation in New York, and an overhead car on the Silver Spring branch of the Steinway road, Astoria. Active preparations for manufacturing motors are already in progress.

The officers of the company are: Conrad N. Jordan, president; Herman Redder, treasurer; Charles W. Spear, secretary; W. M. McDougall, general manager. Those gentlemen, together with Edward Uhl and E. R. Burpee, constitute the board of directors.

ELECTRIC MERCHANDISE CO.

COLD, wintry weather obliges street railway managers to decide how their cars shall be heated and their tracks cleaned. The large business of the Electric Merchandise Company, Chicago, in Burton electric heaters, Brand's patent track brooms, Wardwell's track broom holders and other similar devices is proof that confidence is placed in material, of whatever sort, handled by that company. The past week, equipment of from one to fifteen sets of heaters has been furnished electric roads in the following places: Ottumwa, Iowa; Reading, Pa.; McKeesport, Pa.; Cleveland, Ohio; Lincoln, Neb.; Martinsburg, W. Va.; Salt Lake City, Utah; Sioux City, Iowa., Marquette, Michigan; Wheeling, W. Va; Quincy, Ill.; Williamsport, Pa.; St. Louis, Mo.; Ottawa, Can.; Wilkesbarre, Pa.; Shamokin, Pa.; Bloomington, Ill. Pratt's portable fare register also is meeting with great success.

THE "NOVELTY" ELECTRIC WIRE GAUGE.

THE accompanying illustrations show front and back views, respectively, of a pocket wire gauge recently introduced by the Novelty Electric Co. of 50 to 54 North Fourth street, Philadelphia.

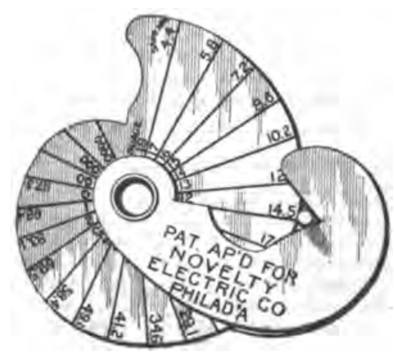


FIG. 1.—THE "NOVELTY" ELECTRIC WIRE GAUGE.

As will be seen, the wire is placed in the V-shaped opening between the movable arm and the edge of the gauge. The arm is then moved around until the wire is tightly bound between it and the gauge, when the radial line from the short square shoulder of the arm will indicate the B. & S. gauge of the wire,

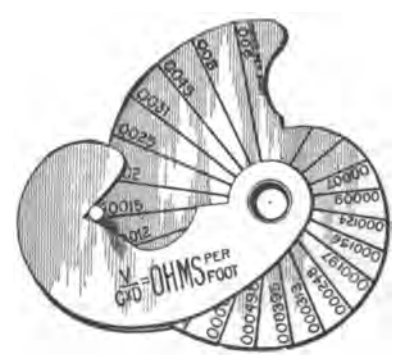


FIG. 2.—THE "NOVELTY" ELECTRIC WIRE GAUGE.

the safe current it will carry in amperes, and the resistance per foot of copper wire in ohms.

With this information, the size of wire required to carry any number of lamps any distance with any loss can readily be calculated by means of the formula stamped on the arm.

THE CRAMP SHIPBUILDING YARD.

WM. CRAMP & SONS Ship & Engine Co., of Philadelphia, are making extensive changes in their plant and have placed the contract for a new boiler shop with the Berlin Iron Bridge Co., of East Berlin, Conn. This boiler shop will be constructed entirely of iron and will be composed of two parts, one part 55 feet in width by 350 feet in length, made very high between joints on account of moving large marine boilers over each other. This portion of the building is controlled by a 50 ton traveling crane, which is to be furnished by Wm. Sellers & Co., of Philadelphia. Connected with this main portion will be a wing 58 feet wide by 370 feet long served the whole length by a 20 ton Sellers traveling crane. The building is composed entirely of iron from the designs of the Berlin Co., and will be one of the most complete in every detail.

AN ELECTRIC ROAD FOR DELWARE, O.

THE city council of Delaware, O., has passed an ordinance granting an individual franchise to Mr. James K. Newcomer, of the *Delaware Democratic Herald*, for a street railroad in that city. The road will in all cover tracks of about four miles in length, with a view to extensions afterwards. The lines will traverse populated portions of the city, one line terminating at the pleasure grounds and lake. It will not be in any sense of the word a road to boom or build up an addition to the town.

Mr. Newcomer wishes to negotiate for the construction of the road and for equipping the same. He proposes to raise the means by bonds, letting the business of the road pay interest and finally liquidate the bonds. He has not yet adopted any system.

TORONTO CONSTRUCTION AND ELECTRICAL SUPPLY CO.

THE above concern, of Toronto, Can., have been appointed by the Thomson-Houston International Electric Co., exclusive selling agents for the Dominion of Canada. The Toronto Co. have their headquarters at 63–69 Front street, Toronto, where they exhibit Wood arc dynamos, Thomson recording watt-meters, mining apparatus, alternating dynamos and transformers, etc., as well as a full line of supply materials manufactured by the International Co. Mr. F. Nicholls, the general manager of the Toronto company, is well-known in the United States, being a member of the Executive Committee of the National Electric Light Association.

NEW YORK NOTES.

THE EASTON ELECTRIC COMPANY has recently completed the installation of a fine incandescent plant in the machine shops of Mr. M. T. Davidson, Keap street near Kent avenue, Brooklyn, N. Y. The plant consists of their No. 6 250-light incandescent dynamo, 180 incandescent lamps of different candle power, and seven Easton "X" arc lamps, burning on the same circuit. The shops are brilliantly illuminated, and Mr. Davidson is now wondering how he ever managed to conduct his extensive business without the light.

THE NEW YORK SAFETY STEAM POWER COMPANY have been awarded the contract for furnishing the Bullitt Building, Philadelphia, with three 13 x 12 horizontal automatic engines for dynamo service. The foundations for the engines are now being constructed and it is expected the plant will be in operation early in December. The Bullitt Building is centrally located, and it is intended to make this the finest and most complete electric light plant in Philadelphia.

MESSRS. CHAS. A. SCHIEREN & CO. have just shipped the Franklin Electric Co., Franklin, Venango, Co., Pa., a 20-inch perforated electric double-ply leather belt. Other belts were shipped last spring when the station was put up, and have been so satisfactory that they have now ordered a main belt.

J. JONES & SON, 602 and 604 West 22d street, New York, continues to put out time stamps. They make a business of manufacturing specialties, and it will pay those who have any new article to put on the market to communicate with them.

WESTERN NOTES.

R. S HUNTON, one of the leading mine owners of Colorado, says that electricity opens up a new era for mine development in Colorado as well as in other localities. Many mines in the higher altitudes, of great promise, have been almost valueless on account of the expense of transporting fuel to them. Now with Pelton wheels and electric motors, mines in the most inaccessible localities can be reached and operated at less expense than those most favorably located as regards fuel supply. The several plants of this character now running at Aspen, Ouray, Telluride and other places have demonstrated beyond all question the practicability and economy of this system.

THE ELECTRIC MERCHANDISE CO., owing to their growing business in electric street railway supplies, to which they devote their entire attention, have leased the entire floor above their sto re at 11 Adams street, and will mo ve their office upstairs. They have built a handsome stairway communicating with the offices, which will be fitted up elegantly and in a manner most advantageous for handling their business. This departure will enable them to take care of their growing trade, carry a larger and more complete stock, and ship more promptly than ever.

THE KNAPP ELECTRICAL WORKS have issued a very neat catalogue of their "Safety" seamless insulated wires and cables for underground, aerial, submarine and inside use. It is of very convenient size and handsomely gotten up with cuts of all the various sylyes of wire, and a number of useful and valuable tables of dimentsions and other data. Attention is also drawn to the general electrical supplies handled and manufactured by the firm and their many specialties.

MR. GEO. H. MEEKER, manager of the Chicago office of the New York Insulated Wire Co., has just received a shipment from the factory of another car-load of wire. Grimshaw is selling as fast as ever, and this large shipment is not likely to remain on Mr. Meeker's hands for any length of time. He is now carrying a very large stock in all the standard sizes, enabling him to make very quick shipments.

THE leading electrical event in Chicago during the past week seems to have been the Chicago Edison Co.'s order for one million feet of braided rubber wire. The supply men made the contest an interesting one, and the decision in favor of Simplex wire is evidently a victory for the unique practice of making a wire with a moderate thickness of rubber, protected by several well-insulated braids. The order was awarded to George Cutter.

THE CENTRAL ELECTRIC CO. are now selling the well-known Soran incandescent lamps, putting in a very large stock of various voltages and candle-power, and are in a position to ship the largest orders with the greatest promptness and despatch. This lamp has an exceedingly good average life, with a small absorption of current, and is said to be highly economical.

THE ILLINOIS ELECTRIC MATERIAL CO. have recently issued a little folder containing price-list, sizes and particulars regarding their Bishop india rubber wires and cables.

MR. H. M. UNDERWOOD, general sales agent of the Knapp Electrical Works, has returned from a trip through the West, and reports business as prosperous and the outlook very favorable for the coming season.

MR. WM. HOOD, No. 239 La Salle street, reports orders for the Jewel incandescent lamps as coming in as rapidly as ever, and the amount of business done as considerably on the increase. The users of the lamp are well satisfied.

MR. R. B. WATSON, of Detroit, is now with the Electrical Fibre Carbon Co. as manager of the sales department. Mr. Watson was in Chicago last week in the interests of the company.

PHILADELPHIA NOTES.

MR. G. A. WILBUR, Philadelphia agent for the Fort Wayne Electric Co., reports the following recent installations: A 150 arc light plant for R. D. Wood & Co., Millville, N. J., to be used for lighting the town; a 40 arc and 600 incandescent plant for the Waynesboro, Pa., Electric Light Co., and two 60 Wood arc light machines for the Frankford Electric Light Co., of Philadelphia.

THE PENNSYLVANIA ELECTRIC ENGINEERING CO. have come out with a new lamp, "The Pennsylvania," which they claim to be superior to other lamps. These lamps are exhausted without the aid of mercurial pumps by a metallic pump, which is capable of producing fine attenuation for incandescent lamp work.

MESSRS. S. A. CROZER & SON, of Chester, Pa., were so well pleased with their 10-inch Westinghouse engine and 400-light plant that they have ordered from Messrs. M. R. Muckle, Jr., & Co., an additional 200 light dynamo which has just been put into operation. This plant displaces gas in every part of the mills.

MR. H. B. GROSS, the proprietor of Brookes' Crystal Soap, has ordered an incandescent light plant of 150 lights for his factory in this city from Messrs. M. R. Muckle, Jr. & Co. Brookes' soap claims "I polish the earth, the moon brightens the sky," and it now falls to the electric light to brighten Brookes' Soap.

THE IMPERIAL ELECTRIC CO. are making a specialty of a ceiling cut-out for a few days. The extremely low price for which they are placing them on the market is making them very popular.

NEW ENGLAND NOTES.

THE GERMANIA ELECTRIC CO., of Boston, has recently installed a Germania dynamo for the Fahys Watch Case Co., Sag Harbor, L. I. This dynamo is made for the especial purpose of running motors throughout their factory, and, like all other Germania dynamos, is giving entire satisfaction and the demand for them is on the increase.

THE CONSOLIDATED ELECTRIC MFG. CO., 154 Franklin street, Boston, Mass., have been obliged by the pressure of their growing business to lease the whole corner of Franklin and Congress streets.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

TELEGRAPH.

Seattle, Wash.—The Western Union Telegraph offices are in a most satisfactory condition. The company proposes extending its lines northward into territory abandoned years ago.

Montana.—The Southern Montana Telegraph and Electric Company has filed articles of incorporation. The capital stock is $25,000, and the principal office at Virginia City. The company will erect telegraph lines from Virginia City to Dillon, Whitehall and Norris, and conduct a general electrical business.

TELEPHONE.

Massillon, O.—The Central Union Telephone Company is rebuilding the city lines. Already 20 miles of the new wire has been stretched.

Reynoldsville, Pa.—The Central District and Printing Telegraph Company, of Pittsburgh, will establish a telephone exchange at Reynoldsville, and also Punxsutawney, this county, and Du Bois, Clearfield county. One has already been established at Brookville, the county seat.

ELECTRIC LIGHT.

Key West, Fla.—The Key West Gas and Electric Light Co. was organized in 1884 with $75,000 capital stock. The Thomson-Houston arc and incandescent systems are used, the circuits being 10 miles in length. Power is supplied by three Ball engines of 315 h. p. N. P. Loring is superintendent.

See further, page xiv.

ELECTRIC RAILWAYS

Delaware, O.—James K. Newcomer is negotiating for a franchise for an electric railway about four miles long. The system has not yet been decided upon.

St. Joseph, Mich.—The St. Joseph and Benton Harbor Street Railway Co. will build three miles more of track, making about eight miles in all. The company want a 250 h p. engine and boiler, two generators and all the necessary suppl es for electrical equipment. W. Worth Bean is president and superintendent.

Defiance, O.—The Defiance Light and Power Co. was organized Aug. 31, 1891, with $100,000 capital stock. The Westinghouse overhead system is used on a track 1½ miles long. There are two Pullman motor cars at present. Power is derived from two Russell engines. About 1½ miles of extension is projected. The officers are: W. B. McKinley, president; E. O. Harris, vice-president; S. L. Nelson, secretary.

Beatrice, Neb.—The Beatrice Rapid Transit and Power Co. was organized Aug. 12, 1890, with $250,000 capital stock. The track is three miles long and three cars equipped with Baxter motors and Brill trucks are in use. Power is supplied by a 100 h. p. Ball engine, with an Erie boiler. An extension of three miles is projected. The officers are: N. N. Brumback, president; G. M. Johnston, vice-president; L. E. Spencer, secretary and treasurer.

See further, page xv.

ELECTRIC LIGHT.

Du Bois, Pa.—An extension of the electric light system is being put in at a cost of $1,200. There will be six more arc lights.

Rahway, N. J.—The new management of the electric light plant is busily engaged in replacing the arc with the incandescent system.

De Land, Fla.—The directors of the Electric Light Company will remove their plant and ice factory from West De Land into De Land proper.

Lambertville, N. J.—The franchise to erect an electric light plant in Lambertville has been granted to the New York Electric Construction Company.

Pittsburgh, Pa.—The Westinghouse Electric Company has now in the course of construction several incandescent light generators and street railway power generators which in capacity and size dwarf all similar machines built in this country. The light generators or dynamos have a capacity sufficient for 10,000 16 c. p. incandescent lamps. The largest previously built have a capacity of 3,000 lights of the same candle power. The new giant railway dynamos will have a capacity of 1,000 h. p., or 750 h. p. greater than the largest generators for this purpurpose previously constructed. The first of these immense street railway dynamos, which is being constructed for a Los Angeles company, is now nearly completed.

ELECTRIC RAILWAYS.

Oakland, Cal.—A site has been purchased for the car and motor house of the Oakland and San Leandri Electric R. R. Co. and work will soon be commenced.

Manchester, N. H.—The Stark Mills are being wired for 2,000 incandescent lights. The Stark corporation is also putting in two No. 32 Edison compound dynamos of 1,300 light capacity each.

San Francisco, Cal.—C. C. Butler, N. Ohlandt and J. A Buck have invested large amounts in the San Francisco and San Mateo Electric R. R. and work will be pushed as fast as men and money can do it.

Ashley, Pa.—The Wilkesbarre and Wyoming Valey Traction Co., capital stock, $5,000,000, expect to extend their line to a total of about fifty miles. The Short system is used. The officers are: B. F. Myers president; John Graham, secretary and treasurer.

Williamsbridge, N. Y.—The certificate of incorporation of the Williamsbridge, Woodlawn and Westchester Railroad Company has been filed in the office of the County Clerk. The road is to run twenty-four miles, from Fordham, through Westchester, Mount Vernon, and to Yonkers. The capital stock of the company is to be $240,000. Among the shareholders are: C. R. Dean, N. B. Thurston, P. W. Cochran, Herbert N. Curtis, Thomas B. Inness, H. D. Lange, John A. Bowers, and W. W. Inness.

MISCELLANEOUS.

Kankakee, Ill.—The Novelty Electric Works is a new institution started here. A. L. Wheeler is the electrician.

See further page xvi.

ELECTRIC LIGHT.

Lenoirs, Tenn.—Dempster & Plummer will put an electric light plant in their flour mill, as reported lately; contract has been let.

Fernandina, Fla.—The Fernandina Light and Power Co. will, it is stated, improve and increase the capacity of its electric light plant.

Washington, D. C.—Walter Hanson, Luke Strider and Frank Aldrich have incorporated the Hanson Battery, Light and Power Co. to produce and furnish electricity for light and power. The capital stock is $1,500,000.

See further, page xvii.

ELECTRIC LIGHT.

Hope, Ark., is to have electric lights. J. H. Black is mayor.

Lynchburg, Va.—The Piedmont Electric Illuminating Co. has put a new boiler in its plant.

Calvert, Tex.—The Calvert Water, Ice and Electric Light Co. will put in an electric light plant.

Sutherland, Fla.—Imhoff & Elliott, of Lincoln, Neb., may erect an electric light and power plant in Sutherland.

Victoria, Tex.—The Victoria Light, Power and Ice Co. will put in a new dynamo to increase the capacity of its plant.

Jonesboro, Tenn.—The Watauga Electric Light and Power Co. is reported as to light the town of Jonesboro with electricity.

Baltimore, Md.—An Edison incandescent electric light and power plant may be erected at Baltimore, as negotiations are now being made to organize a $1,000,000 stock company for that purpose.

See further, page xix.

ELECTRIC LIGHT.

Oakesdale, Wash., will probably have electric lights.

Aurora Springs, Mo., is to be lighted by electricity.

Idaho Falls, Ind., is thinking of erecting an electric light plant.

Roseburgh, Ore.—The electric light plant will soon be in operation.

North Platte, Neb.—The council has been petitioned to light the streets with electricity.

Piqua, O.—The committee on an electric light plant for the city has given a favorable report.

Bangor, Pa., East Bangor and Penn Argyl will be lighted by electricity if rumor speaks with authority.

Lynn, Mass.—The Woodward Underground Electric Light and Cable Co. has petitioned for authority to open streets for the purpose of laying conduits.

Santa Fe, N. M.—According to report, the local Electric Light Company is figuring with the Santa Fé, N. M., Gas Co., with a view of consolidating the two interests.

Washington, Pa.—At a meeting of the directors of the Electric Light and Power Co., it was decided to issue the remainder of the capital stock. The entire issue is $50,000.

See further, page xxi.

ELECTRIC LIGHT.

Chelsea, Mich.—Strong Bros. cf Homer will put in an incandescent plant.

Albany, N. Y.—Funds have been asked for furnishing 31 additional street lights.

Adrian, Mich.—Contracts have been made for the erection of a large addition to the Gilliland Electric plant at Adrian.

Ogen, U.—The Payson Electric Light and Manufacturing Company has been incorporated with a capital stock of $10,000, divided into 200 shares of $50 each.

Bay City, Mich.—The Bay County Electric Co. was organized in April, 1891, with $135,000 capital stock. The Thomson-Houston and Westinghouse systems are used. Power is supplied by three Westinghouse and two Ball engines. The officers are: S. G. M. Gates, president; A. M. Haines, secretary.

Stafford Springs, Conn.—Work is being pushed on the new dam of the Stafford Spring Electric Light Co., and it will probably be completed before the end of the year.

Warren, Mass.—Work on poles and wires for the electric lights is being pushed. The Thomson-Houston system has been adopted. Power will be furnished for 35 arc lights of 1,200 c. p. each, and 45 incandescents of 35 c. p. each.

Mechanicville, N. Y.—An organization to be known as the Mechanicville Electric Light and Power Company has been formed with the following officers: President, Hon. C. R. Sheffer; vice-president, Stephen Lee; secretary, Dr. A. C. Kniskern.

Le Mars, Ia.—J. H. Winchill has been granted a franchise for an electric light plant. The Thomson-Houston alternating system will be used. The circuit will be 35 miles long and composed of K. K. wire. Power will be supplied by a 300 h. p. Sioux City Corliss engine.

Lander, Wyo.—The Lander Electric Light and Power Co. was organized Sept. 7, 1891, with $10,000 capital stock. The Edison incandescent system is used. Power is derived from a 60 h. p. Reynolds-Corliss engine. The officers are: J. D. Woodruff, president; E. Amoretti, treasurer; W. A. Wallace, secretary and manager.

ELECTRIC RAILWAYS.

Iron Mountain, Mich.—J. H. Stevens, of Ironwood, has been granted a franchise for an electric street railway.

Hartford, Conn.—The subject of the trolley electric road to East Hartford has been discussed. The construction is to be under the direction of the street commission and subject to its control.

Lynn, Mass.—The new power station for the Lynn and Boston Railway Co., on Washington street, will be the second largest power station for generating current for railways in the United States, the first being that of the West End of Boston. The capacity of the engines will be 4,000 horse power.

Houston, Tex.—As soon as the 7 new cars are properly equipped the Houston City Street Railway Co. will operate the Glenwood line by electricity. The company will put in a duplicate power plant, and then the other lines will be equipped with electricity as quickly as possible.

Shenandoah, Pa.—The work of building the Mahanoy City, Shenandoah, Girardville and Ashland Electric Railway has been begun. The line, when completed, will be one of the longest electric railways in the State, the length being about eighteen miles. It will connect the four towns above mentioned

Waco, Tex.—The Waco Electric Railway and Light Co. was organized Feb. 26, 1890, with $250,000. The Thomson-Houston overhead system is used on a track 5 miles long. There are 10 motors and 5 trail cars. The light plant furnishes 2,500 lights. Power is supplied by two 150 h. p. Sioux City Corliss engines. The officers are: J. W. J. Hobson, president; H. Moore, vice-president; S. A. Hobson, secretary and superintendent; J. Sleeper, treasurer.

New Castle, Pa.—The city councils have granted the electric street railway right of way through the park. Twenty of the most prominent ladies of New Castle, members of the Park Association, were present and through an attorney protested against the passage of the ordinance. A largely signed petition from business men had been presented urging its passage. The measure went through with only two dissenting votes. The ladies feel very bitter toward councils for its action, and are determined to prevent the proposed encroachment at all hazards. They think this action is a precursor of the ultimate destruction of the park,

See further, page xxii.

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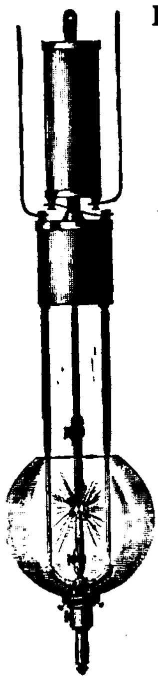
NOTHING EQUALS

THE MOSHER ARC LAMP



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It Gives a Steady, Clear, White Light.

It can be wound so as to yield from 500 to 5,000 c.p. lights, thus making it a very superior lamp for photo-engraving purposes. A trial will convince the most skeptical.

Send for a Circular and Sample Lamp to

MOSHER ARC LAMP CO.,

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The literature of electricity is now growing rapidly, and a knowledge of it is essential to professional men.

All the new books, as well as all the old ones of any value, can be obtained, postage free, on forwarding the price to

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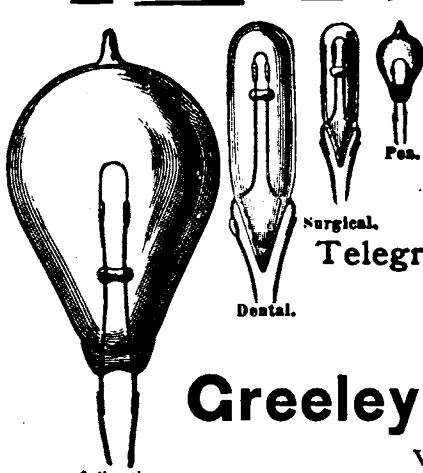

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WE OWN AND OPERATE THE

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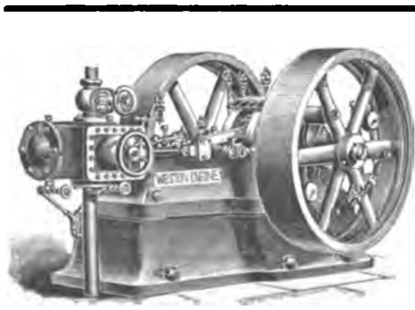
INCANDESCENT LAMPS IN ALL SIZES AND PATTERNS.



JULIAN SCHOLL & CO.,

MECHANICAL AND CONSTRUCTING ENGINEERS.

Weston Automatic Engines,
High-Pressure Boilers,
Complete Power Plants.

40 Cortlandt Street, New York.

ELECTRIC LIGHT.

Madison, Ga.—The electric light plant, previously mentioned, is now being installed.

Greensburgh, Pa.—The proposed Westmoreland Electric Company, but as yet doing business under the name of Morris Painter, has awarded the contract of furnishing the boilers, engines, steam fittings and automatic stockers for the new electric arc light plant to the Russell Manufacturing Company, of Massillon, O., by which the said company have obligated themselves to have the plant in active operation on or before December 21, under a forfeiture of $25 per day for each and every day thereafter until actually completed. The Corliss type of the Russell engine, with four valves, will be used. Western Electric dynamos and lamps will be used.

See further, page xxiii.

ELECTRIC LIGHT.

Newark, N. J.—The Wolverton Arc Electric Light Co. has been formed with $250,000 capital by J. E. Wolverton, W. McCubben and J. L. Cox of New York City.

Milton, Ore.—Milton has bought an electric light plant, Edison system, for 15 arc and 200 incandescent lights, at a cost of $4,025. The power will be furnished by the mill wheel, which is driven by water from the Walla Walla river.

South St. Louis, Mo.—The Carondelet Electric Light Plant will soon be ready for operation. The engines and mammoth dynamos are in position, and Col. O. A. Haynes, manager of the plant, will make the final test of the machinery.

Missoula, Mont.—It is said that a Missoula syndicate, represented by J. R. Cox, have purchased the electric light plant, which was built by Bowen Bros. & Thompson, the foundry men. The new concern is said to contemplate extensive improvements, including an arc system, which will be extended to Granite.

Somerville, Mass.—The Somerville Electric Light Company is constantly adding to its plant, taking on new business and increasing its facilities. The new 300 h. p. engine is now running and the 300 horse boiler will soon be steamed up. Another dynamo for incandescent lighting is expected within a week for 1,300 lights.

Delaware, O.—One of the new dynamos ordered by the Electric Light Co. has arrived. It is a 50-light (arc) Sperry automatic dynamo made in Chicago. The other to arrive is a 1,500 light (incandescent) Westinghouse machine. There are already in use three Thomson-Houston dynamos, two arc lights with a capacity of 50 lights each, and an incandescent 550 lights. The latter is greatly overtaxed, having carried at times as high as 200 extra lights. The power for these is furnished by automatic engines of 180 and 150 h. p.

ELECTRIC POWER.

Tarkio, Mo., will in all probability be given an electric road early in 1892.

Buffalo, N. Y.—The Thomson-Houston Company of this city is establishing power circuits independent of lighting circuits. They are of 500 voltage each, and each one furnishes 100 h. p.

St. Louis, Mo.—The gearless motor car of the Short Electric Railway Co., which was exhibited at the annual meeting of the American Street Railway Association, Pittsburgh, has been purchased by the Lindell Railway Co., and will be put in their regular service.

See further, page xxiv.

ELECTRIC RAILWAYS.

Ottawa, Ill.—The Electric Power Railway is about ready to commence operations.

Montgomery, Ala.—The Council has refused a franchise for an electric car line.

Middletown, Pa.—The Middletown Highspire and Steelton Railway Co. has been granted right of way through this borough.

Oshkosh, Wis.—The Oshkosh Railroad Company amended its articles of incorporation, increasing its capital stock from $60,000 to $100,000.

East Side, Ore.—The power house of the East Side Railway is being pushed rapidly. It is being built near a saw mill so that the sawdust can be used as fuel.

Camden, Pa.—A $5,000 Edison generator has been contracted for by the Camden Lighting and Heating Company for the use of the Camden Street Railroad Company.

Spokane Falls, Wash.—The Spokane Street Railway Co. has asked for permission to haul freight cars over the tracks of its electric lines in the city between the hours of 12 midnight and 6 o'clock a. m.

Braddock, Pa.—The Braddock Electric Street Car Company has decided to sell annual tickets for $25 each, which will entitle the holder to as many rides daily on the company's cars as he may wish.

Washington, Pa.—During the first six months of the operation of the electric street railway of Washington, Pa., 155,000 passengers were carried. This shows that the electric road will pay a handsome dividend.

Ronceverte, W. Va.—The Ronceverte Electric Company has been incorporated for the purpose of operating electric street railways, supplying electric power for the same and supplying the citizens of Ronceverte with water. The principal office is to be kept at Ronceverte. The capital is $500, with the privilege of increasing to $100,000. Col. E. C. Best, of Ronceverte, and other parties, from Baltimore, are the incorporators.

See further, page xxv.

ELECTRIC RAILWAYS.

Modesta, Cal., is now lighted by electricity.

Oakland, Cal.—The car-house and motive power plant of the Oakland and San Leandro electric road has been definitely located on the Warner tract, which will be the centre of a new suburb.

Beverly, Mass.—The Beverly selectmen gave a hearing at the town hall on Nov. 19, on the petition of the Naumkeag Street Railroad Co. to extend its trolley wires to the Wenham line, through Rantoul street. The hall was crowded and the most intense partisan excitement prevailed. H. P. Moulton closed the argument for the Naumkeag road, showing that the opposition came from the Beverly & Danvers Railroad because the Naumkeag would not buy it. The petition was refused, the vote resulting: 332 no; 325 yes. At the last hearing the vote was: Yes, 240; no, 299.

See further page xxvi.

ELECTRIC LIGHT.

New Orleans, La.—The inhabitants of the Sixth District want electric lighting.

Southwest Greensburgh, Pa.—The town council of Southwest Greensburgh borough has decided to purchase arc lights for the borough.

Columbus, Ind.—The 10-years' franchise which was granted to H. Bailey for an electric light plant was almost immediately sold to the present company for $6,000.

Provo, Utah.—A water power has been taken up on the river northeast of Provo by parties whose names are unknown, but it is rumored that an electric company is preparing for operations.

Fairfield, Me.—The blasting for the wheel pits at the electric light station has been finished. The flume will be 48 feet long, 13 feet wide and 11 feet deep, and upon the bottom will be set the three wheels.

Hudson, Mass.—The town has voted 84 to 60 that it was not expedient or advisable to purchase or operate an electric plant, after listening to the minority report in favor and the majority report against the project.

Greensburgh, Pa.—The dynamos and engine for the electric light plant for the Frick company's new Standard shaft have arrived and are being set up. It is expected to have the plant in operation by December 1.

Melrose, Mass.—Action on the report of the committee upon the manufacture by the town of its own gas and electricity was postponed by the annual town meeting until an adjourned meeting, which will be held in March.

Greensburgh, Pa.—The People's Electric Light Company are now taking bids for two 45 arc dynamos, in addition to the three incandescent dynamos now in operation. The additional dynamos will, it is thought, be in operation inside of fifteen days.

Latrobe, Pa.—The Electric Light Company, of Latrobe, refused to accept the amendment submitted by the council, at a former meeting, in reference to a penal clause for permitting a lamp or lamps to be in darkness beyond a reasonable time. The matter was referred to the finance committee and solicitor.

Sanger, Cal.—Says the *Sanger Herald:* "The Sanger Electric Light Company, of which Messrs. H. W. Chase and N. G. Kittle are the principal stockholders, are erecting a steam power house on the east side of the railroad. The cellar has been excavated for a one story brick building 32x80 feet, the walls to be of brick and the roof corrugated iron."

Chester, Mass.—A subscription paper is being circulated to raise funds necessary to light the streets with electric lights. Some $200 has already been pledged and the solicitors feel confident they will get enough for 12 lights. The Hudson & Chester granite company are putting electric lights into their works and will furnish for private individuals and the streets.

See further, page xxvii.

ELECTRIC LIGHT.

Brightwood, Ind., wants electric lights.

Kewascum, Wis., is to have electric lights.

Bremen, Ind.—Electric lighting is contemplated.

Elk Rapids, Mich.—The citizens are in favor of electricity.

Xenia, Ind.—A municipal electric light plant is spoken of.

Gibson City, Ill., will probably soon have electric lights.

Marshalltown, Ia.—The recently incorporated Marshall Electric Light Co. has a capital of $50,000.

Sioux City, Ia.—The Storage Battery Co. has been formed by E. M. Dunbar, J. F. Peavey and C. S. Wallis. Capital, $1,000,000.

Meyersdale, Pa.—The Electric Light Company will probably spend from $15,000 to $20 000 on its plant.

See further, page xxviii.

ELECTRIC LIGHT.

Frankfort, Ind., is now lighted by electricity.

Paragould, Ark., wants electric lights.

Grand Rapids, Mich.—The Grand Rapids Electric Light Co. has received permission to build a large oil tank on the west side, the oil to be used for running the plant.

Litchfield, Ill.—The Litchfield Light, Heat and Power Company has been formed with a capital stock of $50,000; incorporators, H. H. Beach, J. B. Wamsden and Robert M. Foster.

Houlton, Me.—A 650 incandescent light alternating machine, from the Thomson-Houston Works, has been purchased by the Houlton Electric Co. When this machine is in running order the plant will have a capacity of 1,000 lights.

Taylor, Tex.—At the initial meeting of the Taylor Electric Light, Gas and Power Company, held a few days ago, the capital stock was placed at $40,000, in shares of $100 each, and a charter was ordered to be prepared.

Duluth, Minn.—The Phœnix Electric Company has filed articles of incorporation with the register of deeds. The capital stock is $110,000; directors and incorporators, Joseph M. Anderson, Robert B. Eyster, Henry R. Fisk, Jr., and Margaret Eyster, all of Duluth.

White Plains, N. Y.—The Gas and Electric Company and the Westchester Telephone Co. have been directed to remove some large new poles recently erected. The companies, having received permission in the first instance, will probably invoke the aid of the law.

ELECTRIC RAILWAYS.

Colfax, Col.—An electric storage battery road from Colfax to Barnum is proposed by F. A. Arbuckle, L. L. Gray and M. S. Noah.

Sandusky, O.—The People's Electric Street Railway Co. has been accorded permission to lay its tracks on the Milan road.

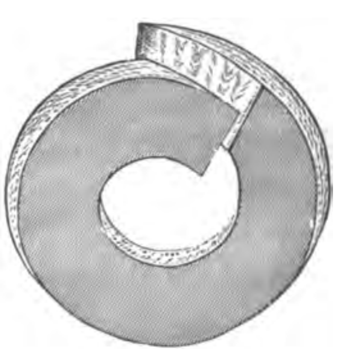
Brooklyn, N. Y.—The Coney Island and Brooklyn Railway Co. has been given permission to convert its road to a single-trolley overhead electric system.

Galveston, Tex.—A franchise has been granted to the South Galveston and Gulf Shore Electric Railway Co. for a line 13 miles long. President, Geo. J. Gray, of Denver, Col.

Bradford, Pa.—The petition from the Electric Light and Power Company asked the right to use the streets and alleys of Bradford for constructing and maintaining a track for electric street cars of the overhead trolley system. Signed by H. G. Rose, secretary.

Raleigh Springs, Tenn.—The Raleigh Springs Electric Railway Co. will build an electric road 11 miles long to Memphis, and track-laying will be commenced in December. The Thomson Houston Co. will furnish the electrical equipment. President, Daniel O'Connor; general manager, W. R. Hall; chief engineer, E. T. Lynch.

See further, page xxix.



ELECTRIC RAILWAYS.

Sacramento, Cal.—Large amounts have been pledged for the electric road to Perkins.

Salem, Ore.—The Capital City Railway Co. has asked for permission to extend two of its lines.

Chicago, Ill.—The International Electric Railway Co. has been formed by J. T. Hanna, M. M. Wood, D. L. Coe. Capital, $2,500,000.

San Francisco, Cal.—Work has been commenced on the car house of the Metropolitan Electric Railway, which will cost about $14,000. The company's franchise is for an electric road to Golden Gate Park. About $125,000 have already been expended in track-laying, &c.

Aspen, Col., has outgrown the horse car system and work on the electric car lines will be commenced early in the spring.

Colma, Cal.—The petition of J. W. Ellis and associates for a franchise from Colma to Half Moon Bay, for an electric road, has been allowed by the San Mateo board of supervisors. Work is to begin at both ends of the road within six months.

St. Louis, Mo.—An application has been made by the St. Louis and Kirkwood Rapid Transit Company for the privilege of constructing and operating an electric railway from the limits of the city of St. Louis to Kirkwood. The petition was signed by George Johnson and Joseph Lawson, of New York, and George M. Keeley, Edward P. Dickson and Edwin B. Sherzer, of St. Louis.

ELECTRIC LIGHT.

Niles, O.—By action of the council, the Niles Electric Light and Power Company were granted the privilege of hanging their wire on the city poles.

Newport, R. I.—A special dispatch of Nov. 22 from Newport says: A sensation is expected to-morrow when it is known that the Edison Electric Light Company of this city has made an assignment. John Whipple is the assignee. He declined to talk on the subject to-night. Col. Hovey, the counsel for the company, said that the action was taken by vote of the stockholders. For some time the company has owed $5,000 to John N. A. Griswold, and it has other debts in Newport, he said, amounting to $50,000. Griswold pressed for payment and threatened an attachment, which was withheld upon the promise that an assignment would be made.

See further, page xxx.

ELECTRIC LIGHT.

Woodstock, Ill., is thinking of electric lights.

Montgomery City, Mo.—After a trial the city has decided on having electric lighting.

Creston, Ia.—The electric light plant of O. Q. Holman has been greatly improved.

Farmington, Ill., has a franchise and has contracted for incandescent electric lights.

Clifton Forge, Va.—Electric lighting is found to be very satisfactory in this place.

Springport, Mich.—Springport citizens say the town will have electric lights.

Brooklyn, Mich.—Electric lighting is being discussed.

Melrose, Mass.—The service of the Malden Electric Light Co. here is being improved.

Louisville, Ky.—Electric lights have been accidentally delayed, but are now ready for operation.

Burlington, N. J., wants arc instead of incandescent lights at the street corners.

Gardner, Mass.—The Gardner Electric Light Co. has been formed with $30,000 capital. R. L. Bent is president.

So. Framingham, Mass.—The chimney of the Milford Electric Light Company's factory has been blown down. Damage, $250.

McKeesport, Pa.—A decision in favor of the Edison Company has been rendered by Judge Stowe in the suit between the two factions of the McKeesport Light Company.

TELEPHONE.

Albany, N. Y.—It is said that there is a possibility that the Law telephone system will be adopted for the new telephone exchange at Albany.

See further, page xxxv.

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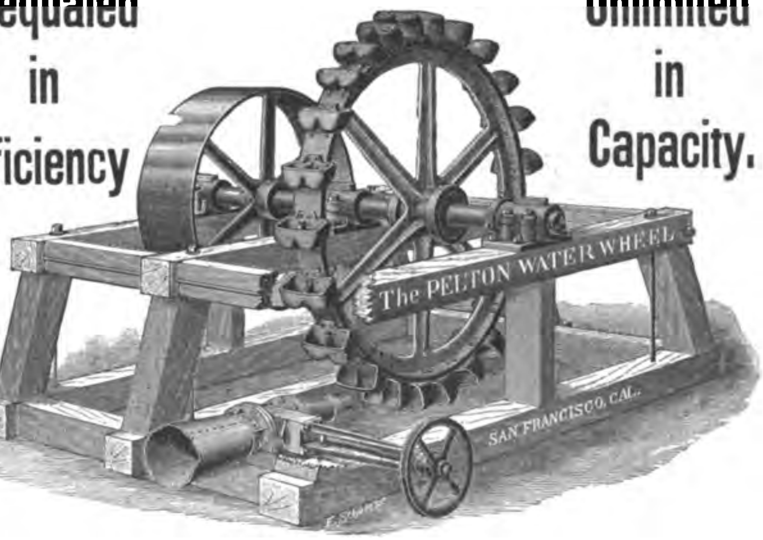
Unlimited in Capacity.



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Deliveries made from San Francisco or New York, as may afford the most favorable freight rates.

It having come to the notice of the undersigned that their patent rights are being infringed upon, intending purchasers are hereby warned that all such infringements will be duly prosecuted.

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SPEED! ACCURACY!! ECONOMY!!!

In weighing Coal, Coke, Grain, Lumber, Stock and heavy car-load freight of all kinds, on Railroad Track Scales, are the three necessary elements to be considered and sought for. These are absolutely guaranteed by the use of

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Davis Automatic Electric Track Scale.

This Scale is entirely automatic in operation, weighing the car and PRINTING THE WEIGHT, without manual intervention, by the mere act of rolling the car upon the platform.

The weight is printed in plain figures on the bill of lading, the card-way-bill or a ticket, as desired.

SPEED.—An absolutely correct balance is obtained within one second after the car comes upon the platform. Cars can be weighed while in motion (if disconnected from other cars), rolling over the platform.

ACCURACY.—The Scale MUST be at a correct balance before any weight is recorded. The car must be entirely on the platform before the poise begins to move. The Scale will not weigh or register a weight unless all the wheels of the car are on the platform, or if more than one car be touching the platform. The weight is printed automatically the instant the Scale comes to a correct balance.

ECONOMY.—The Scale saves the labor (and wages) of a weigh-master. Being absolutely infallible, it saves thousands of corrections and claims for over and short weights, over charges, etc., etc. It simplifies the claim agent's department, eliminating as it does all doubt as to accuracy of the weight.

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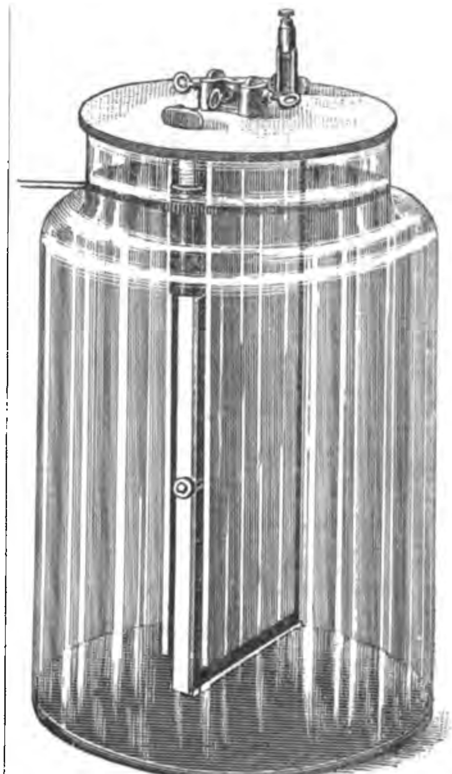

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Switchboards.

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New York, J. H. Bunnell & Co., 76 Cortlandt Street.
Philadelphia, Walker & Kepler, 531 Chestnut Street.
" Novelty Electric Co., 50 North Fourth Street.
Baltimore, Md., Southern Electric Co.,
North and Lexington Streets.
Washington, D. C., Royce & Marean, 1408 Pennsylvania Ave.
Pittsburgh, Pa., Robbins Electric Co., 39 Sixth Avenue.
" " Electrical Supply and Construction Co.
Cincinnati, O., Post & Co., West Fourth Street.
St. Louis, Mo., St. Louis Electric Supply Co., Locust Street.
Kansas City, Mo., Gate City Electric Co.
Salt Lake City, Utah, United Electric Co.
Portland, Ore., Northwest Electrical Engineering Co.
St. Paul, Minn., Columbia Electric Co.
Chicago, Electrical Supply Co., 102 Michigan Avenue.
" Central Electric Co., 116 Franklin Street.
Cleveland, O., Electrical Supply Co., 115 Public Square.
Buffalo, F. P. Jones & Co., 255 Pearl Street.
" F. P. Little & Co., East Seneca Street.
Albany, N. Y., Robinson Electric Co.
Boston, Holtzer-Cabot Electric Co., 92 Franklin Street.
Atlanta, Ga., Gate City Electric Supply and Construction Co.
New Orleans, Southern Electrical M'f'g and Supply Co.,
112 Baronne Street.
Augusta, Ga., W. E. Platt.
Atlantic City, N, J., P. J. Leigh, Atlantic Ave.

Surgical Instrument Houses.

New York, J. Campbell, 34th Street and Lexington Avenue.
" P. Schmidt, 34th Street and Broadway.
Philadelphia, E A. Yarnall & Co., 1020 Walnut Street.
" C. Lentz & Son, 18 North 11th Street.
Washington, D. C., J. U. Birkett & Co.
Pittsburgh, Pa., Feick Bros., 21 Sixth Avenue.
" " Artificial Limb M'f'g Co., 909 Penna. Ave.
Cincinnati, O., Max Wocher & Sons.
" W. Autenreith.
Louisville, Ky., Tafel Bros.
Indianapolis, Ind., W. H. Armstrong & Co.
St. Louis, Mo., A. S. Aloe & Co., 415 North Broadway.
" " Mellier Drug Co., 518 Olive Street.
St. Paul, Minn., Noyes Bros. & Cutler.
Milwaukee, Spiegel, Crolius & Co.
Chicago, Chas. Truax & Co., Wabash Avenue.
" Sharp & Smith, 73 Randolph Street.
Cleveland, O., E M. Hessler Surgical Instrument Co
Detroit, H. J. Millburn & Co.
" A. Kuhlman.
Buffalo, Stoddart Bros., Seneca Street.
" H. Herrmann, West Huron Street.
Rochester, Paine Drug Co.
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ELECTRIC RAILWAYS.

Ashland, Ky.—The Ashland and Catlettsburgh Street Railroad Co., W. L. Ringo, president, will take steps at once to extend its road to Catlettsburg and change from animal to electric power.

Baltimore, Md.—William H. Parmenter, of New York City, and S. L. Dows, of Cedar Rapids, Ia., are said to contemplate the purchase of the Highlandtown and Point Breeze Street Railway for a New York syndicate. If the sale is made the road will probably be operated by cable through the city and by electricity in the suburbs.

Galveston, Tex.—The South Galveston and Gulf Shore Railroad Co., previously reported as to build an electrical railroad from Galveston down the island to South Galveston, a distance of about 18 miles, has been granted right of way on certain streets by the city council. The company expects to commence work at once and build the line as speedily as possible.

See further page xxxvii.

Conduits for the National Capital.

PRESIDENT BENJAMIN HARRISON, under authority of an ACT OF CONGRESS, having appointed a Commission to report on the disposal of the electric wires in the DISTRICT OF COLUMBIA; that Commission, composed of ANDREW ROSEWATER, C. E.; PROF. HENRY A. ROWLAND, and LIEUT. F. R. SHUNK, U. S. A. Engineer Corps, has reported unanimously in favor of the

Lynch and Lake System of Underground Electric Wire Conduits.

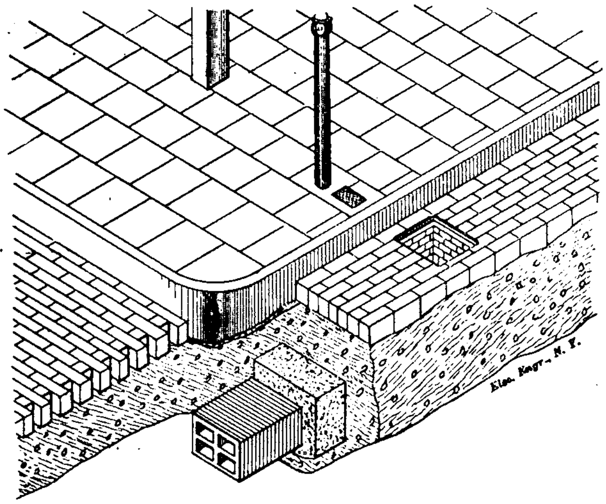

Fig. 1.

This endorsement is the more striking and convincing from the fact that this Expert Commission made a most thorough and exhaustive personal investigation of all the work done in Europe and the United States in placing wires underground. In other words, and not to put it too strongly, the Lynch and Lake System is declared by these authorities to be **the best and most practical in the world,** and the only one fit for adoption at the seat of Government.

****

In view of this important decision, a few words descriptive of the system will be interesting.

The main idea embodied in this conduit is to provide a system which shall permit of the ready insertion and withdrawal of the conductors, while at the same time being of a nature such that its life is practically indefinite. Evidently a construction embodying only terra-cotta and concrete employed in a suitable manner fulfills these conditions exactly. The Lynch and Lake Conduit is composed of ducts built up in tiers of terra-cotta, which lasts forever, in the shape of rectangular troughs, the bottom of the upper forming the top of the lower. These ducts are covered above and below by a cover. This is set in a bed of concrete, which also completely surrounds the ducts and keeps them firmly in position. A type of conduit with four ducts is shown in Fig. 1, which represents the hand-hole by which connection is made with the wires leading to the lamp-post at the curb. The construction adopted where more conduits are required is shown in Fig 2. Here the conduits are composed of four units of four conduits, each set in concrete as before. The joints between the consecutive lengths are effected by bracket-shaped pieces, D, Figs. 2 and 3, which clasp the conduits, and which are held firmly in position by the concrete as it is rammed about them. The system has also been thoroughly provided with the various hand-holes and manholes necessary for getting at the wires.

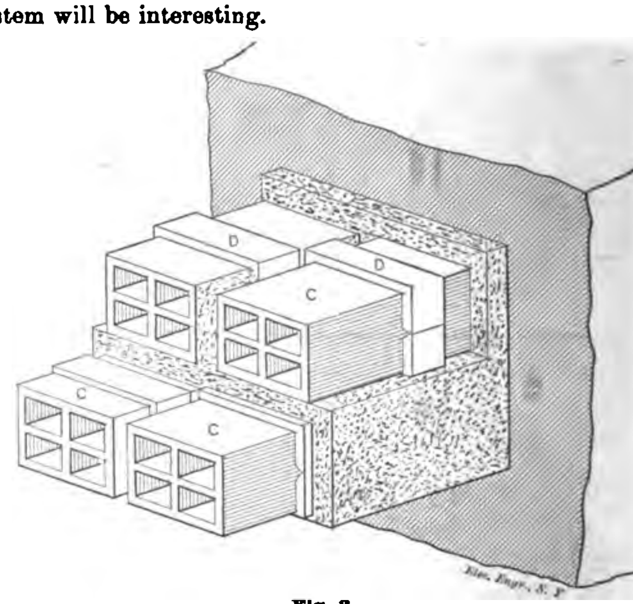

Fig. 2.

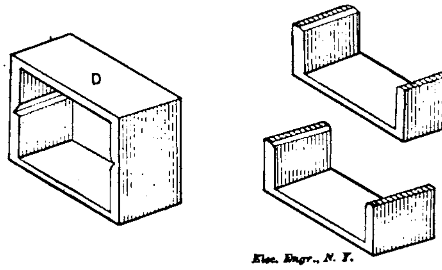

Fig. 3.

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GOODWIN Y. ATLEE, Secretary.

OWNERS OF

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Room 36, Corcoran Building, Washington, D. C.

TELEGRAPH.

Des Moines, Ia.—The American District Telegraph Co. has asked for four years more of exclusive right, and will put its wires underground.

Augusta, Me.—The city government will put in a fire-alarm system.

See further, page xxxix.

THE

Emerson Electric Mfg. Co.,

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The "Spring Clip" Cut-Out (new model),
The Meston Alternating Motors,
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The Midget Fixture Cut-Out.
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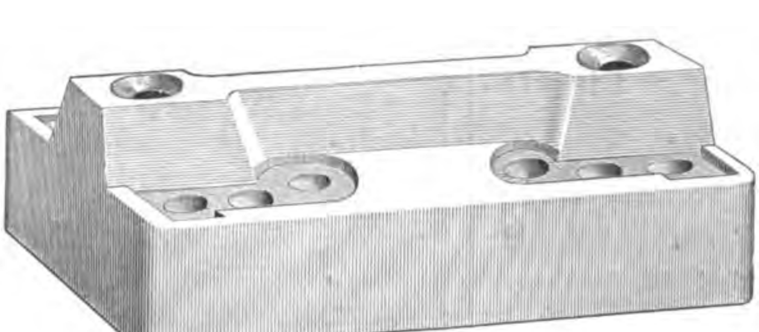

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" 52. 25 "
" 53. 50 "
" 54. 100 "

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Small Sample of Slate, Plain and Marbleized, free.

A. BONVILLE,

FAIR HAVEN, VT.

All my Slate is Easy to Drill and Free from all Conducting Material.

TELEPHONE.

Tucson, Ariz.—Business people here are complaining of the lack of telephone facilities.

Pottstown, Pa.—The Delaware and Atlantic Telephone Co. has made great improvements in its service.

TELEGRAPH.

Astoria, Ore.—Articles of incorporation of the American District Telegraph and Electrical Construction Association are drawn up. The incorporators are: James S. Urquhart, J. R. Lowman, and J. W. Crow. The capital stock is $30,000.

Columbus, O.—The Columbus Auxiliary Fire-Alarm Company, of Columbus, with a capital stock of $20,000, has been incorporated by Philip H. Bruck, E. W. Poe, N. B. Abbott, J. N. Koerner, George C. Kraus, and John N. Stewart.

NEW HOTELS.

Detroit, Mich.—A $10,000 hotel is to be lighted by electricity.

North Baltimore, O.—A hotel for L. Wiese will cost $15,000 and will have electric lighting.

ELECTRIC LIGHT.

Rock Hill, S. C.—The Rock Hill Electric Light Co. was organized last year with $10,000 capital stock. Both light and power will be furnished, the National system being used. The circuit is five miles long. A 200 h. p. Russell engine will furnish the power. J. M. Cherry is president, and D. Hutchinson, treasurer.

Pittsfield, Mass.—The Pittsfield Electric Co. was organized July 14, 1890, with $100,000 capital stock. The Westinghouse, Thomson-Houston and U. S. systems are used to supply both light and power. The circuits are 25 miles in length. Power is furnished by a 350 h. p. Harris-Corliss, and three 240 h. p. Westinghouse engines. The officers are: Alex. Kennedy, president; W. A. Whittlesey, manager and treasurer.

Great Falls, Mont.—The Boston and Great Falls Electric Light and Power Co., and the Great Falls Street Railway Co., organized under the laws of New Jersey, have an aggregate capital stock of $350,000. The Thomson-Houston system is used. There are two 80 h. p. generators, and three incandescent, and four arc dynamos, supplying 3,900 and 200 lights respectively. About 70 miles of K. K. wire is used. The officers are: A. S. Bigelow, president; Leonard Lewisohn, vice-president; C. H. Bissell, secretary and treasurer; W. D. Dickinson, superintendent.

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HEAVY CARBONS FOR REDUCTION WORKS A SPECIALTY.

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The Dovetail Ceiling Cut-Out

No. 101—For CLEAT WORK.
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(See Illustration.)

No Screw Driver in Adjusting Cap to Base.

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SWITCHES FROM 5 to 150 AMP.
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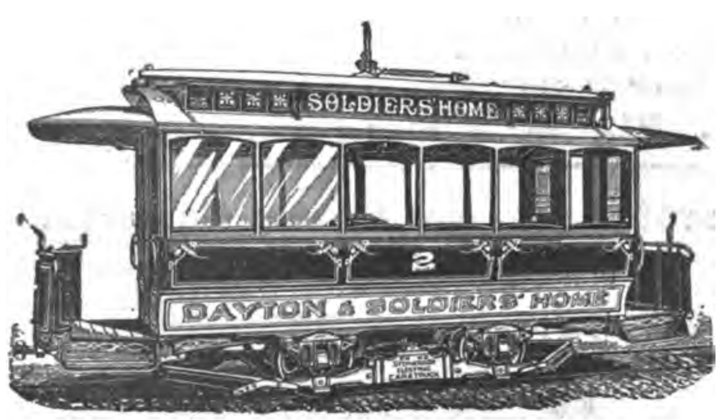

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UNION ELECTRIC WORKS,

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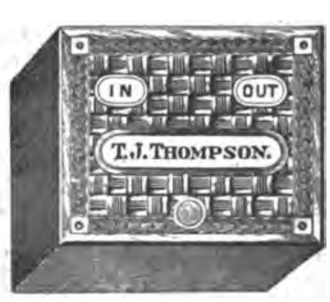
Also the only perfect **GRAVITY ANNUNCIATOR** invented. No springs to get out of order.

Four drop, $3.50, and seventy-five cents for each additional drop. Guaranteed satisfactory.



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Chicago, Ill.

Bells, Spark Coils, Test Instruments, Etc.,

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We will also manufacture articles for Inventors or the Trade. We have skilled workmen, and do first-class work.

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WHY DO YOU BUY SWITCHES?

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READ THIS.

We will, for 30 days from the date of this notice, give away ten five-ampere or nine ten-ampere Porcelain Base Paiste Switches to any one sending us an order for one hundred dollars' worth of goods, accompanied by this blank—filled in and signed.

CENTRAL ELECTRIC COMPANY,

Nov. 23d, 1891.

CHICAGO.

To CENTRAL ELECTRIC COMPANY,

CHICAGO.

Please send with accompanying order ....

Ampere Porcelain Base Paiste Switches, for which you are to make no charge.

[Signed] ....

.... *1891.*

TRADE-MARK.

CHICAGO, November 16, 1891.

To Our Customers:

We have just completed arrangements with the Swan Lamp Manufacturing Company to handle their lamps, and will, in future, sell this company's lamps in preference to any others. We have heretofore been selling the Packard Lamp, and in making the change we do not wish to be understood as retracting any of our claims for that lamp. We are simply keeping pace with the wishes of our patrons, who demand a lamp of high efficiency and good average life rather than one of low efficiency and extra long life.

As the electric lighting industry becomes one of the stable dividend-paying interests of the world, station managers are obliged to pay more attention to every source of waste, and there has hereretofore been none more prolific than that of low efficiency lamps, especially when the capacity of the station is full.

The Swan Lamp is one of high efficiency and good average life—say, from 600 to 1,000 burning hours—while it does not blacken to any appreciable degree, even when it is nearly burned out. These lamps are made to fit any socket, and, as we will carry a stock of all ordinary candle powers and voltages, orders can be promptly filled.

CENTRAL ELECTRIC COMPANY

116 and 118 FRANKLIN STREET,

Connected by Private Wire with Postal Telegraph Cable Co.'s System.

CHICAGO.

THE

Electrical Engineer.

VOL. XII. DECEMBER 9, 1891. No. 188.

THE EVOLUTION OF THE EICKEMEYER-FIELD STREET CAR MOTOR.

DURING the Summer of the year 1883 an exhibition of railroad appliances was held in the city of Chicago, one of the chief features of which was an electric railroad, the first ever constructed and operated in the United States for business purposes. Application was made by the board of managers to Mr. Stephen D. Field, one of the principal contestants in the Patent Office for the basic patents on electric railroads, requesting him to construct and operate an electric railroad at that exposition. But a few weeks were available for the construction of such a system. While the apparatus employed was necessarily crude and hastily thrown together, the success of the installation was complete. Thousands of passengers were carried and the whole organization of an electric railroad, financial and mechanical, was exemplified.

The motor employed on this occasion is shown in Fig. 1. It was of about 15 horse-power nominally, but was eventually worked far in excess of this figure. At the conclusion of the Chicago Exposition the motor was removed to the State Fair at Louisville, where many passengers were carried.

FIG. 2.—ELECTRIC LOCOMOTIVE EMPLOYED ON N.Y. ELEVATED RAILROAD, 1887.

The operation of this road suggested many points of importance in electric railways to Mr. Stephen D. Field, which have been incorporated with other features suggested by Mr. Rudolf Eickemeyer, and these gentlemen have joined forces under the name of the Eickemeyer-Field Company.

The first installations of electric motors on street railroads were made upon horse street railways, the roadways of which consisted of light centre-bearing rails resting upon longitudinal wooden sleepers. The motors were mounted on one or both axles of the street cars, rigidly supported at one end on the axle, the other end being supported on springs of more or less resilience. It was soon found that the tracks showed signs of wear greatly in excess of that formerly experienced in horse traction, this result being in some cases wrongly ascribed to the extra load caused by the weight of the motors. As has been stated, one end, or at least half the weight of the motors, was borne directly by the axles without the intervention of springs to relieve the blow due to the inertia of the motor when passing from the end of one rail to that of the next. This blow was of greater or less impact, varying directly as the weight of the motor and the speed at which it was driven. As a natural result, the rails soon became dented and bent down at their ends, forming a depression into which the car wheels dropped in passing, the rebound from such a drop resulting in another blow to the rail a short distance along in the direction of travel, this in time, forming a cause for a third and fourth depression, until finally the tracks became unfit for traction purposes and heavier rails were substituted. Now, the rail being of exceptional rigidity, the destructive action of the jar was transferred to the motors, causing destruction of gears, springing of axles, burning out of armatures, etc.

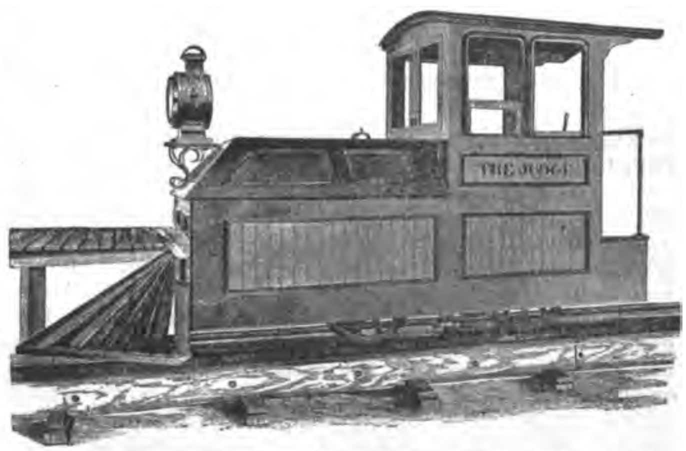


FIG. 1.—FIELD'S ELECTRIC LOCOMOTIVE "THE JUDGE," 1883.

To eliminate this bad effect, in the Eickemeyer-Field apparatus all the weight of both motor and car is supported on springs, the motor forming part of the car body and moving with it, so that the wear of the motor on the track is no greater than that caused by a loaded horse car, while the motor in turn is so cushioned on springs that the passage over irregularities of track or ordinary street obstructions results in no perceptible jar to the mechanism, the motor being absolutely rigid in the direction of travel and cushioned on springs vertically.

The first demonstration of this combination of mechanism was shown in some experiments conducted on the Thirty-fourth street branch of the New York Elevated Railroad during the summer of 1887. This motor is shown

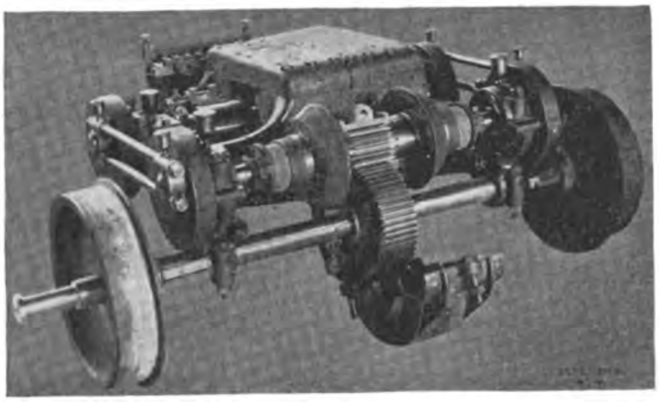


FIG. 3.—EICKEMEYER-FIELD SINGLE REDUCTION MOTOR.

in Fig. 2. Fearing that it would be impossible to design a motor of slow speed which should at the same time be of such small dimensions that it could be chambered under an ordinary street car, the motor Fig. 3 was constructed. This, it is claimed, was the first successful introduction of what is now termed "single-reduction gearing." It will be seen that in this design a gear-wheel was rigidly bolted to the car axle, this meshing into a cut steel pinion, both gear and pinion being enclosed in a dust-proof oil box, one-half of which is shown in the illustration as detached and on the ground.

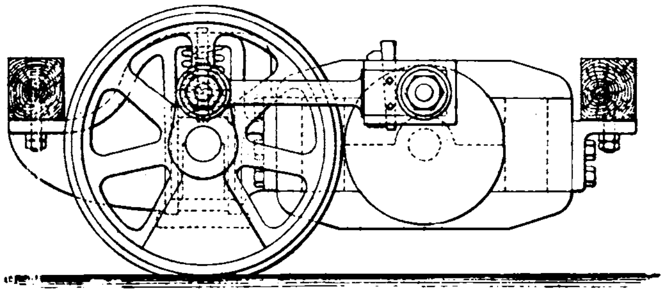


FIG. 5.—EICKEMEYER-FIELD DIRECT CONNECTED MOTOR.

Connection between the pinion and armature shaft was obtained by parallel rods between either end of the armature shaft and the pinion; these rods terminated in crank arms which were set at an angle with each other at either end of the respective shafts. The armature had a speed of 644 revolutions per minute. The parallel bars transmitted this speed of revolution to the pinion without vibration or other indication of reciprocating action. Three of these motors were run during three successive seasons a distance of from 8,000 to 10,000 miles each without any perceptible wear on the gearing or other moving part.

The excellent results obtained by these single-reduction motors showed the possibility of the suppression of all gearing on street car work and led to the construction of the motor shown in Fig. 4, wherein the motor is coupled to parallel rods and by them direct to the driving axle of the car without the intervention of any gearing. In this motor the good features of the Eickemeyer-Field apparatus were prominently brought out, and its operation was all that could be desired. It will be observed that in this motor

FIG. 4.—EICKEMEYER-FIELD DIRECT CONNECTED MOTOR.

the driving wheels were of smaller diameter than those supporting the other end of the car. As such a feature would, in some cases, be objectionable, the design shown in Figs. 5 and 6 was constructed, with wheels of uniform diameter throughout, to a single pair of which the motor armature is coupled by parallel rods, as shown in Fig. 4.

Several months' operation with motors of this type upon a road having at one place a grade of 11¼ per cent., showed that even on a grade of this amount but a single coupled axle was necessary to obtain sufficient tractive adhesion for a single car. Fig. 7 shows an instantaneous photograph recently taken at Lynchburg, Va., of a car of this type ascending an 11¼ per cent. grade.

To provide for still heavier grades and to utilize all the attached weight for tractive adhesion, the motor shown in Fig. 8 was constructed and adopted as the standard Eicke-

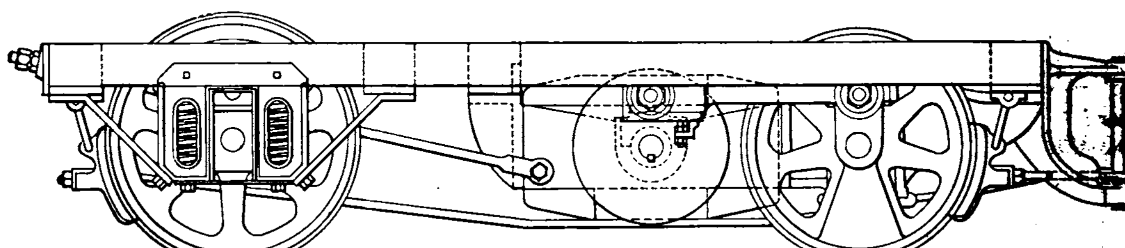


FIG. 6.—EICKEMEYER-FIELD DIRECT CONNECTED MOTOR.

meyer-Field car motor. This motor has nominally 35 horse power; the wheels are 26 inches in diameter; armature speed, 150 revolutions per minute; weight, including wheels, axles and fittings, 9,000 pounds.

for use on elevated railroads or on surface roads where great speed of train movement is desired.

There are many advantages derived in the use of this type of motor. All the wheels moving in unison renders

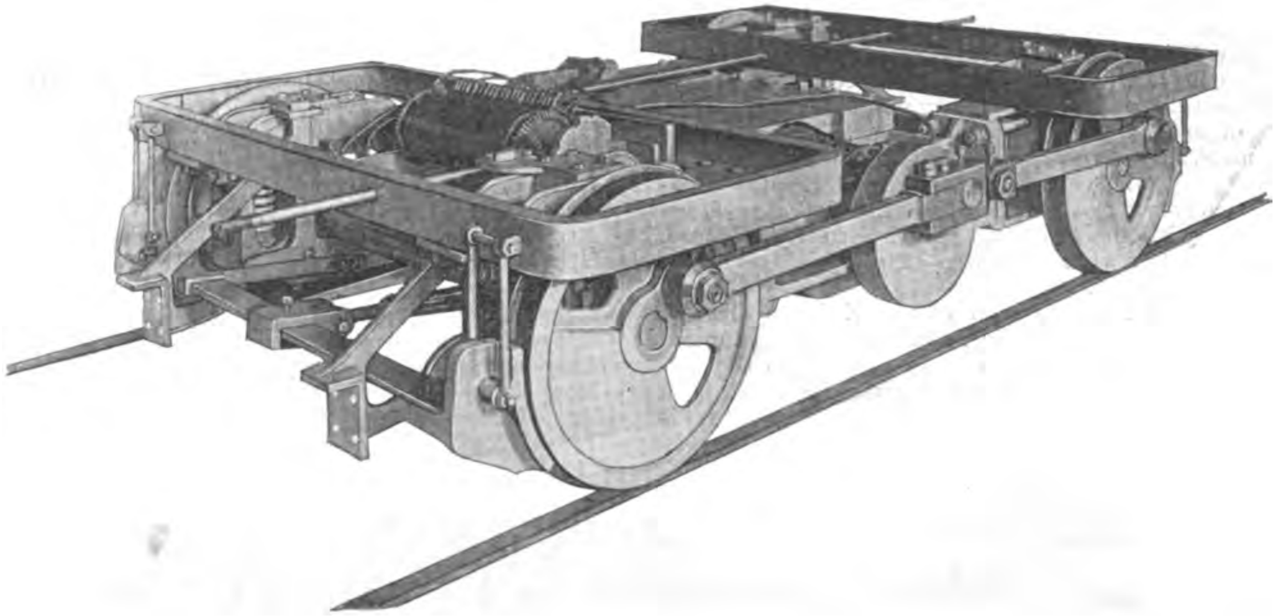


FIG. 8.—STANDARD EICKEMEYER-FIELD CAR MOTOR.

FIG. 7.—EICKEMEYER-FIELD CAR, ASCENDING 11¼ PER CENT. GRADE, LYNCHBURG, VA.

It is an interesting feature of the Eickemeyer-Field designs that they impose no limitations as to size or power of motor. Consequently, this mechanism is peculiarly adapted

a slipping on grades or wet rails almost an impossibility. Again, more power for a given weight can be had from one large motor than from two small ones, while on long vestibule cars two of these motors mounted as bogie or swivel trucks give an installation of great power and flexibility.

The feature of parallel rods as a connecting medium between the motor armature and driven wheels, while producing the same beneficial results of shock insulation, is materially different from the connecting rods as used on a steam locomotive. In the latter the connecting rods have a reciprocating, as well as a rotary, motion. The impossibility of balancing the reciprocating motion is a feature which materially decreases the speed at which a steam locomotive can be driven. Not so, however, with the parallel rods, every point of which, when in motion, describes a true circle, with the centrifugal force perfectly balanced, so that, no matter what the speed of rotation, no jarring action is experienced.

The mechanical construction of the Eickemeyer-Field apparatus is exceedingly simple. Fig. 9 shows an armature complete with crank discs ready to place in the machine. The frame supporting the armature shaft is a single, nearly square, casting within which the armature is mounted; its bearings, being bored at a single operation, are necessarily in exact alignment with the pole faces. This frame is entirely closed underneath, so that no mud or moisture from the street can penetrate. At either end of the motor frame are bolted the pedestals carrying the springs and axle bearings upon which the whole motor and car body are supported. The motor is entirely governed by a detachable crank-arm or wheel, located, preferably, on the dashboard at either end of the car. It is very easily controlled, speed and direction being governed by a single lever, and as the diameter of commutation in this machine is at an exact right angle with the pole faces, it follows that movement of the armature in either direction is accomplished without change in the brush position.

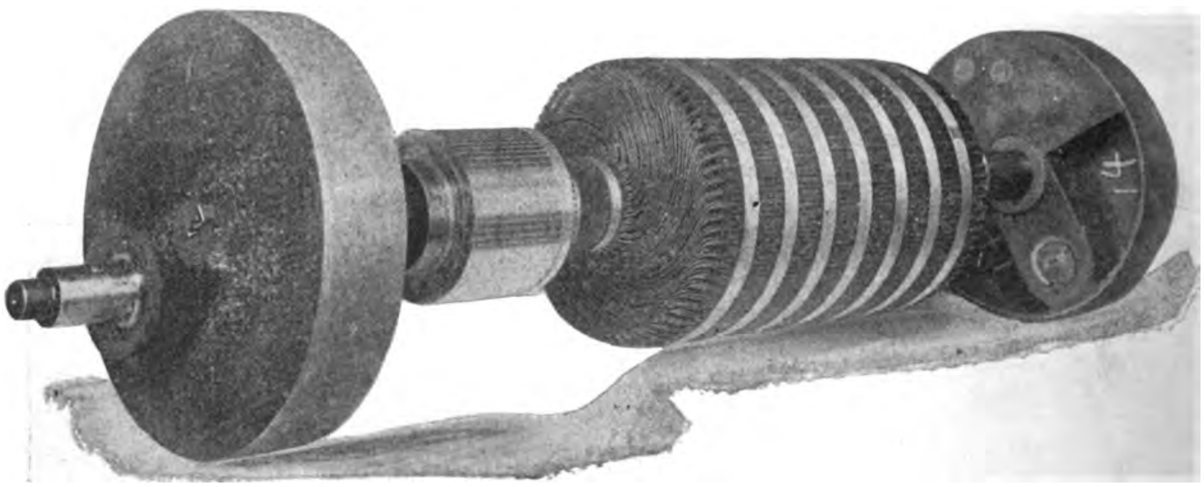


Fig. 9.—Eickemeyer-Field Armature with Crank Discs.

LINEFF TRAMWAY.

Mr. Lineff, the designer of the magnetic continuous closed-conduit system, has lately been engaged in an interesting investigation with regard to the insulating properties of various kinds of combinations of asphalt under extreme climatic conditions of wet, cold and heat. This is comparatively fresh ground for experiment, as until the present only the mechanical properties of asphalt have been studied. It will be remembered that Mr. G. Kapp a short time ago made a test of the Lineff system, which gave very satisfactory results.

AN ARGUMENT FOR ELECTRIC HEATERS.

BY

W. R. Mason

St. Joseph, Mo., Nov. 30.—[Special.]—Last night one of the cars on the street railway was run into the barn with a fire still burning in the stove. The stove became overheated and set fire to the car, which in turn fired the barn. Thirty-two cars, all the cars on the line, were consumed, together with the repair shops and storage house. Loss, $60,000; insurance, $30,000.—*Chicago Tribune.*

All people regret misfortunes which from time to time befall worthy corporations. Such misfortunes, however, may convey seasonable and emphatic warnings to those at the time more fortunate. Street railway managers may well consider the above item a "special" to themselves, and seriously contemplate replacing older methods of car heating by those more modern and, at the same time, safer and more efficient. For two years past electrical heating, especially for street cars, has been growing in popularity, and that because of its intrinsic merit. More than eighty-five roads have put electric heaters upon their cars because they are absolutely safe, absolutely clean and absolutely reliable. Doubtless many roads are using stoves for the simple reason that they have them and believe it extravagant to equip their cars with electric heaters while their stoves are at all serviceable. Such economy is practiced at a risk. An expense of several thousand dollars due to a previous saving of a few hundred dollars is hardly profitable.

It is not held that the use of stoves is inevitably followed by such disastrous results, but it is a fact that it is at the weakest points of a machine or organization that misfortune will strike. Because of their triteness, we are prone to forget certain little sayings, as for instance, "An ounce of prevention is worth a pound of cure," which contain much good advice.

But it is encouraging to mark the rapid progress in electrical heating. It must certainly satisfy the most exacting mortal. The same comment also might well be made in regard to the operation of electrical heaters now in use. But electrical heaters are not to be considered merely as a safeguard against some great loss as that recorded in the *Chicago Tribune.* As now operated upon street cars, they are economical. They remove the necessity of new stoves every two or three years and of new parts oftener, while the cars, due to the absence of smoke and dirt, retain for a longer time their cleanly appearance and, consequently, their utility.

THE PLANT OF THE EASTERN ELECTRIC CO., LTD., ST. JOHN, N. B.

During the present year The Electrical Engineer has had the pleasure of drawing attention to a number of American electric light and power plants installed in Central

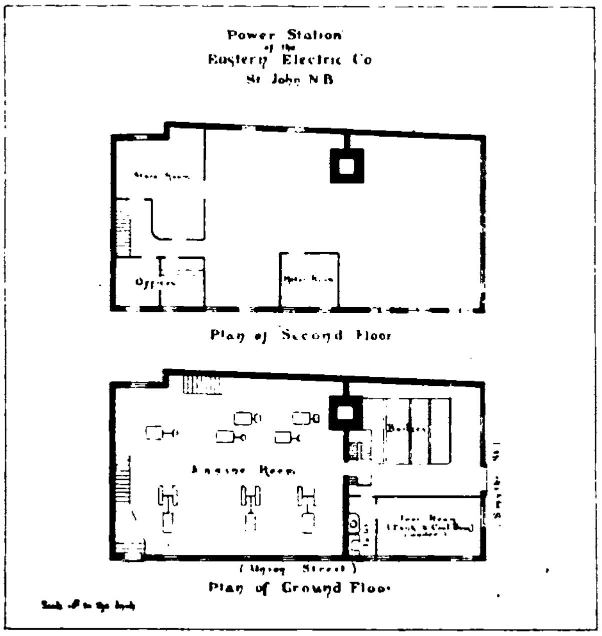


Fig. 1.—Plan of Eastern Electric Light Co.'s Station, St. John, N. B.

and South America and the West Indies. Readers of this paper will remember the fine Westinghouse plant at Havana, Cuba; the Thomson-Houston plant at Kingston, Jamaica, and the Fort Wayne plant at Barranquilla, U. S. C., all of which have recently been illustrated and described in our pages. But American enterprise has been not less active to the north of our border than in the tropics, and it is gratifying to know that apparatus of American make, or embodying American ideas and inventions, is becoming

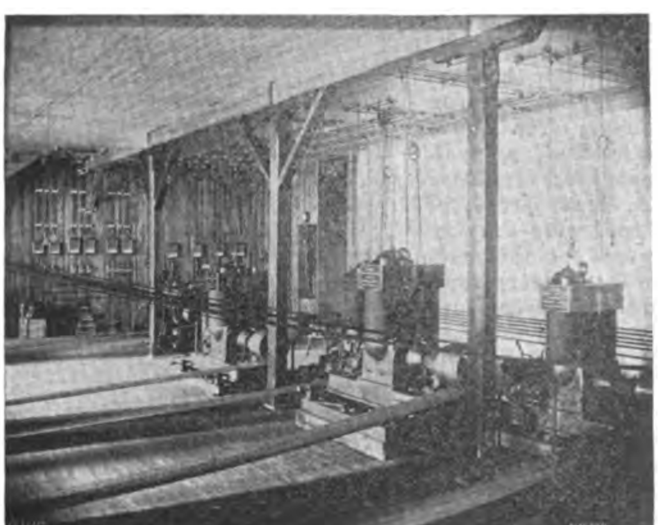


Fig. 2.—Dynamo Room, St. John, N. B., Station.

widely known through the Dominion of Canada. Some of the best examples are probably to be found in the Eastern and maritime provinces, and among these may fairly be placed the plants at St. John, New Brunswick. The development of electric light and power there is peculiarly due to American initiative, seconded, of course, by the genuine love of improvement and progress on the part of the Brunswickers. In 1889, thanks to the zeal of Mr. A. A. Knudson, a New York electrical engineer, who had done much to develop the telephone in Canada, St. John had an electrical exhibition, one of the earliest, if not the first, to be held in a British colony. It was the good fortune of the present writer to visit that beautiful exhibition and to be able to do something in cultivating popular local interest in it. The results of the display were very soon seen, and certainly one could not well wish for a more conspicuous proof of them than in the plant illustrated in this article.

The Eastern Electric Co., Ltd., of St. John, was most lucky in its choice of a site for its station, (Figs. 1, 2, 3 and 4), for the location combines many advantages, including two great essentials to economical construction and successful operation—a solid rock foundation and nearness to tidewater. As Mr. Fred. S. Pearson, the engineer of the Boston West End Road, put it, after a recent visit: "Had the city of St. John been laid waste and all its property placed at the disposal of the Eastern Electric Co., a better site for an electric light plant could not have been chosen." The site, at the corner of Union and Smyth streets, has a frontage of 136 feet and 50 feet. Of the 136 feet, a space 102 by 50 is taken up by the power station, while the remainder is now covered by a shed used as a warehouse, and

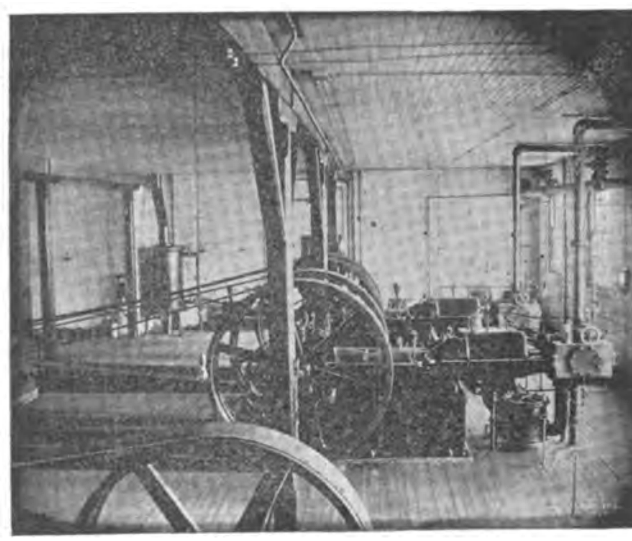


Fig. 3.—Steam Plant, St. John, N. B., Station.

held in reserve for coming extensions. The boiler house is 36 feet long by 50 deep, and the engine and dynamo room is 66 feet by 50. Under the entire property extends a firm, dry slate ledge, affording the best possible foundation for an electric plant. A few yards from the station are wharves fronting upon the harbor of St. John, where the coal used by the company is landed; while from the deep waters of the harbor itself can be obtained for the mere cost of laying the pipe an inexhaustible supply of water for condensing. Moreover, the station is peculiarly well situated for the exploitation of the Edison system. It stands right in the heart of the business portion of the city, and within a radius of one mile is contained the profitable lighting area of the snug, compactly built city.

The building itself is substantial, and even massive, being built of brick with stone trimmings. It has a gravel roof. The lower floor is occupied by the boiler, engine and dynamo rooms, ample cellarage being found underneath. The upper floor is used for offices, storeroom, meter-room, etc. The chimney is also of brick, square built, 5 feet in diameter and 100 feet high. The foundations are all of block granite, built up from the sheer bed rock in such a manner that any settling of the structure is utterly impossible. A novel feature worthy the attention of power station architects in moist climates, is the arrangement for the drainage of rainwater from the roof. It is built sloping to a centre, thus forming a catch-basin, whence leads an iron pipe, to a tank situated in the boiler-room. This iron pipe from its contiguity to the brick chimney and exhaust, is not liable to be frozen up even in the coldest weather. The evident advantages are a material saving in galvanized iron for gutters and drain-pipe and the utilization of the rainwater for boiler purposes.

The boiler house, 36 by 50 feet, is excavated about 18 feet below the street level and that of the engine beds, thus making the distance between the floor and the roof nearly 40 feet. This more than ordinary height in a medium sized station is a great help to the boiler-room, and is duly appreciated by the workmen therein. The steam-generating equipment consists of four Heine safety steel water-tube boilers, in all 500 h. p. These are provided with patent rocker grates and Jarvis boiler setting. A noticeable thing in connection with these boilers is the thickness of their steel plates, being nearly seven-eighths of an inch, thus insuring long and reliable service. In this boiler-room and immediately facing the furnace doors are situated the coal vaults, which have a storage capacity of about 250 tons. These are accessible from the rear by means of shutes extending from the sidewalk, so placed

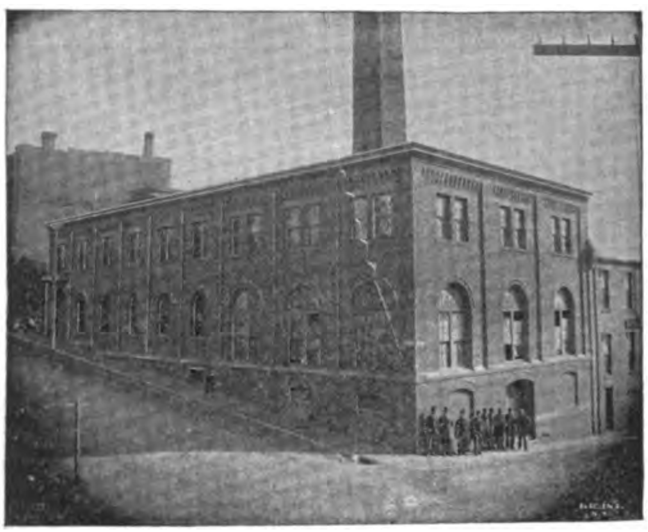


Fig. 4.—Exterior New Eastern Electric Light Co.'s Station.

that the contents of a coal cart can easily be deposited therein. Directly over the coal vaults, and supported by iron pillars passing through them, is the tank mentioned above; this is made of wood with the seams thoroughly caulked, and its capacity is 15,526 gallons. The purpose of this tank is a double one; first, to serve as a receptacle for the rain-water passing from the roof through the iron pipe already mentioned, and second, as a reservoir for a reserve supply of water in the event of the city water being shut off through an accident to the mains. It is estimated that at the present capacity of the station this tank will supply water for boiler evaporation for a space of 10 hours, which should be time enough to effect any ordinary repairs to the street mains. Above the tank and extending the whole length along the top of it, which serves as their flooring, are an engineer's work-room and a toilet-room. All parts of the boiler house are light, airy and cheerful, which materially conduces to the health and comfort of the employees.

Passing from the boiler house up a flight of iron steps, leading over the top of the boilers, and so placed as to allow an easy inspection thereof, we approach the door of the engine and dynamo room, which opens upon a platform made to overlook the boiler fronts, and enter the engine and dynamo room. Here are two engines of 138 nominal h. p. each, made by McIntosh, Seymour & Co., furnishing power to run four Edison No. 16 incandescent dynamos with current capacity for 3,000 incandescent lamps, while a 100 h. p. Armington & Sims does similar duty for a Wood arc dynamo, operating 61 street lights for the city of St. John. A No. 14 National feed water heater is used and two Knowles No. 5 feed pumps, one of which is held as a reserve. Economy in oil is secured by the aid of a "Common Sense" oil filter. The station incandescent electrical apparatus is of the standard Edison type, and the arc apparatus is of the well-known manufacture of the Fort Wayne Electric Co.

John F. Zebley.

The engines are placed upon beds of brick and cement and are fastened by anchor bolts to a ledge of slate rock three feet below the engine-room floor. Beds of solid masonry, built up from the rock, furnish a foundation for the dynamos.

At the present time the dynamos are belted direct to the engines with link and endless leather belting.

A flight of stairs leads from the main entrance of the building to the second floor. Adjoining the main building and facing Union street is the shed at present used for storing the company's heavy supplies, and under which is a coal cellar of about 400 tons capacity, now being made to contain a reserve supply of coal for use during the winter months, when the navigation of the Bay of Fundy—the water route for fuel—is uncertain. From the rear of this coal cellar a slight decline admits of the easy carriage of coal to the boiler house, by way of the cellar under the dynamo-room.

A. A. Knudson.

The station was constructed from the plans and under the superintendence of G. Ernest Fairweather, a well-known local architect. J. A. Grant & Co., of Boston, were the contractors for the erection of the steam plant, and the electrical work was done by the Edison General Electric Co. The construction of building and designing of the plant generally was done under the supervision of Mr. A. A. Knudson, the company's electrician. The executive officers of the company are: John F. Zebley, of New York, president; H. B. Zebley, New York, vice-president; A. A. Knudson, electrical manager; Charles D. Jones, business manager.

The plant started in January last, and up to the present time the company has confined its attention to high and low-tension arc lighting and incandescent work. The St. John City Railway Co., with whom the Eastern Co. has entered into a contract to furnish power for the operation of its motor cars, is now engaged in wiring its track, preparatory to the introduction of an electric service under the Edison system. This, in connection with stationary motor work for which there is a growing demand, will add a profitable increase to the revennes.

Thus far the income from lighting has exceeded the most sanguine expectations, and an early increase of the plant is now being considered. Any desired increase in the plant can be secured at a comparatively small additional outlay, as in the acquisition of the real estate as well as in the construction of the building a careful eye has been had to future requirements.

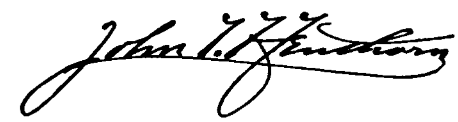
It will have been clear from the above description that the company enjoys a number of advantages making for economy and success, and tending to render the property a very handsome investment and one of the standard institutions of St. John. But with a keen perception of its opportunities in a new and growing field for electrical work, the Eastern Company is adding to its other earning departments a somewhat novel one. It has been customary for local companies to do their own repairs and not a little new construction, but in this instance the corporation is going in for the manufacture of insulated wire, under Canadian patents recently acquired by purchase from the inventors of the process of insulation, Mr. A. A. Knudson (one of the inventors of K. K. wire) and Mr. C. Cuttriss, the well-known electrician of the Commercial Cable Co. These patents cover new principles and methods in the art of insulation, and while thus giving St. John a new industry, will utilize many special advantages by being under the same roof as a large steam and electric plant. It will thus be seen that the Eastern Electric Co. bases its operations very broadly and will derive revenue from a variety of sources, any one of which has often been found productive of large dividends. We understand that steps will be taken later for the manufacture of this wire in the United States. We are glad to bring this development of electric light and power in New Brunswick to public notice, not simply because American apparatus plays so large a part in it, but because it is largely due to the intelligent work of two Americans, Mr. Zebley, a New York banker, and Mr. Knudson, whose faith in the growth and enterprise of the maritime provinces has led to this promising investment of capital there.

FRENCH ELECTRICAL INSTALLATION RULES.

The French "Union" Fire Insurance Company has procured from MM. Bunel and Picou a full report as to the precautions which in their opinion should be taken in the use of electricity. The principal recommendations of the report are as follows: The current density is not to exceed 2 amperes per sq. mm. (1,300 amperes per sq. in.) in wires of 10 sq. mm. (No. 9 B.W.G.) section and above, and 3 amperes in the case of smaller wires. Bare conductors are to be prohibited in buildings, and only allowed in exceptional cases in workshops. The protection of the conductors must be double, electrical and mechanical. The current leakage must not exceed one-thousandth of the total flow. The use of earth, or of gas or water pipes, or metallic girders, for return currents, is forbidden. The fuses must be double, and must melt with not more than a three-fold current. Resistance-coils must not be heated more than 100° C. Glow lamps must not be put on gas-fittings unless the gas is definitely cut off. Every place containing accumulators to be classified as dangerous, and to be subject to special precautions. Places where gas and electric fittings coexist to be classified as dangerous or very dangerous. The fire risk of gas lighting being represented by 4, the report concludes by estimating the risk as 3, when the electric lighting stands alone and the above regulations are strictly carried out, and as 3 to 5, if there be any imperfection in the fittings.

THE ECONOMIC LIMITS OF LARGE POWER UNITS IN ELECTRIC WORK.

BY



An article under the above caption in your issue of November 4, p. 500, by "Carleton," appears to require a little attention from the fact of the many broad statements, both made and implied, as to the alleged superiority of the high-speed engine for electrical service over that of the slow or more rational speed engine. These statements, appearing as they do in such a prominent publication of wide circulation, make it the more necessary that they should not stand uncontroverted, even though the article in question has the appearance of emanating from a source interested in this class of engine, if not prompted by business motives.

I fully agree with "Carleton" that it is proper and desirable to divide power up into proper units, but our differences at once develop when the amount of power is suggested that shall constitute such units, and as illustrating the folly of putting all the eggs in one basket the gas-holder problem is used by him. This is all right, but the unit, I contend, must be in proportion to the population and demands, and not insist that, because East Greenwich, say, has two holders, the city of Philadelphia shall have twenty holders, each of like capacity, when five could be made of equivalent capacity for the work at much less cost for maintenance.

If I were to build an electric light plant for 100 arc lights I should, no doubt, if money was scarce, couple these two machines to a moderately high-speed engine, the same as many of our now large stations were first started with. But as the growth of the station developed, a time would come where the multiple in power first selected would be entirely out of proportion to the magnitude of the station's business, thus making it imperative from a financial, as well as from a practical, standpoint that the motive power should be consolidated and engines of a power more in keeping with our resources used; this policy, I am aware, is foreign to the placing of eight engines of 150 h. p. each for a load of 1,200 h. p. The comparison in the cost of maintenance (which of course includes fuel, repairs, supplies, etc., and floor space occupied) between eight engines of the high-speed type and a modern slow-speed engine is obvious, and decidedly, in my mind, in favor of the slow-speed cut-off type.

It has been urged that variableness in the load precluded the satisfactory use of a compound or triple-expansion engine, but this is merely a theory of a would-be authority, which the actual facts of many cases about the country do not confirm, for the reason that if a station requires a multiple in power of 1,000 h. p. the demands of that city are such as to naturally provide a constant and uniform load, for at least ten hours, at from 900 to 1,100 h. p. and often for a much longer period. If we take an extreme case and suppose, for the sake of argument, that the engine must run a portion of its time at 50 per cent. of its rated capacity, even under these conditions it is far superior both in point of regulation and economy to the high-speed class, as it has been proven that a triple-expansion engine, working at half load, will develop a horse power with 14½ pounds of steam, and at its rated load less that 13 pounds. This certainly is a good record for an engine working under extreme conditions.

"Economy in floor space" and absence of a "multiplicity of parts," which tend to "increase the liability of disaster," are urged in favor of the high-speed type. This fact is true in the first item where two engines of like capacity, say, 150 h. p., but of different types, are placed alongside of one another, and constitute a multiple adapted to the requirements of a town of small proportions. If we fix upon this size of engine as the multiple for a station in a thickly settled city of five hundred thousand inhabitants, the question of real estate and the multiplicity of parts would assume a financial proportion not pleasant to contemplate, to say nothing of the men and boys required to keep them in repair, furnish the oil and look tolerably shipshape to receive company occasionally. Implied broad statements that nothing short of a high-speed engine can turn an armature at a satisfactory rotative speed and do this in the only known economical method, when all points are considered as to first cost, fuel, supplies, etc., is going beyond the bounds of engineering propriety; and facts do not warrant this belief, notwitstanding "many electric engineers have in no way changed their views from the first concerning the size and style of engines for electric requirements."

Business interests sometimes allow a man to admit that his neighbor builds the next best engine to his, as a prominent Corliss cut-off engine manufacturer once admitted to me. But I have yet to learn of a case where an admission was made of equality. The fact is that the type of machinery selected has more influence upon the question of dividends than the mere theories and pet engines of office experts.

Taking up that portion of the article touching on electric railway service, the statement regarding the severity of such work we all know; but it is a new problem to me that such variation produces a blow on the piston, and the consequent probability to disintegration of the machine as a whole. Up to this time I had assumed that the maximum pressure communicated to the cross-head and crank-pin, main bearing, etc., was the product of boiler pressure multiplied by the area of the piston, and that it was immaterial whether this pressure was maintained during 1 inch or 36 inches of the piston's travel, as regards any blow or dangerous element. Of course, if the steam is allowed to follow 36 inches on the stroke before cutting off much more power will be generated, but the maximum initial pressure upon the piston will be precisely the same as though the steam followed 1 inch or 100 inches, and I cannot, therefore, realize the cause for alarm that a long-stroke engine is going to pieces if coupled to an electric generator. Such engines are in successful operation, and, I surmise, will continue to so run with a very small fraction of cost for repairs as compared with that of the high-speed type.

If "Carleton" is familiar with rolling-mill practice he must have seen engines of 2,000 h. p. run from a friction load up to full stroke and all within one stroke of the piston's travel. The rolling of hard steel billets is quite rough work and about as severe as other service.

In speaking of the alleged blow on the piston from a variation in load, the absence of compression was pointed out as a serious objection to the automatic cut-off engine of the slow-running type. I am free to say that any Corliss engine can be made to run smoothly with a very small amount of compression, as its successful operation does not depend upon such an extreme compression pressure, as is so essential to the existence of the high-speed type, and which may be classed as a necessary evil; it is quite common to find a high-speed engine with compression exceeding that of the boilers; this loss of power and its resultant additional friction requires no comment or argument save that it is essential to the safety of the engine and inherent in that construction.

Reference was made to the fallacy of running a non-condensing compound engine, and in support of that theory the Corliss Steam Engine Co. and the Armington & Sims Engine Co. were quoted as declining to build engines of that class. This declination does not seriously affect well-known laws regarding the mechanical application of steam, for the principle of dividing the ratio of expansion between two or more cylinders for a given cut-off has been proven too often beneficial to be now ignored because a manufacturer did not take kindly to the proposition of a client. "Comment" in this case, also, may be said to be "unnecessary.

It is a well-recognized fact among flour-mill men that if a non-condensing engine with steam at 100 pounds will turn out a barrel of flour for 32 pounds of coal it is considered as a "crack" equipped mill; yet I have figures, whose accuracy can be vouched for, where a mill of precisely the same class of machinery and capacity is doing the same work on a consumption of 24 pounds of coal per barrel of flour with a non-condensing compound engine of the slow-running type. Both of these cases include wheat-cleaning machinery and elevators; and I will go still further and say that the duty of this class of engine of the slow-moving type has an economy about equal to an ordinary non-steam-jacketed condensing engine.

Following the article along we find that "Carleton" "regretted that numerous electrical engineers are for the sake of personal advancement constantly bringing forward, at the expense of the shareholder, new and untried experiments in special engines." This, I should think, indicated a line of progress and a desire to improve upon existing methods, and should be commended, rather than regretted, even though the engineers may obtain new light upon this branch of engineering and possibly contrary to existing theories of the upholders of the high-speed class. I recall cases where such dissenting engineers have reduced the item of fuel alone 66 per cent., which the stockholders fully appreciated.

It is true that the measure of economy of the steam engine is determined by the consumption of steam per horse-power per hour, and it is for this very reason that many of the principal electric lighting stations of this country, whose officials have fully considered the cost of fuel, maintenance, etc., are substituting compound engines for the high-speed type. I would not be understood for a moment as intimating that the high-speed engine is nearing its end; far from it, as it has a mission which it can, and does, perform successfully, and I draw the line only where the cost of coal would preclude its unconditional adoption.

Triple-expansion engines were suggested by "Carleton" as possibly admissible if the load could be steady and uniform, and reference is made to a well-appointed central station where a triple-expansion engine was officially tested and the report thereon was, as he states, 12.5 pounds of water per indicated horse-power. For the information of this gentleman I would say that this engine of 500 nominal h. p. (assuming that he refers to an engine running at Providence) was connected to water-tube boilers and an 18-inch steam pipe, which latter was designed for 4,000 h. p., and the amount of condensation in a pipe of this size and length (about 125 feet) was, as can be readily imagined, considerable, in addition to that carried over by the boilers, and was the cause of the allowance of 7.39 per cent. of entrainment or moisture. The report gives the result as 12.9 pounds of water per indicated horse-power. This amount of condensation and moisture was one of circumstances and not chargeable to the engine, which our friend would recognize if he were to test a high-speed engine under like circumstances and conditions. There have since been added two engines, one of 1,200 h. p., also of the triple-expansion type.

This explanation is made in the hope that it will be plain to our friend and his colleagues, and, as the official report is very clear as to details, I should be pleased to furnish a copy for his and his friends' perusal if his address is made known to the editors of THE ELECTRICAL ENGINEER or myself. And he will upon perusal see that a marked improvement has been made in steam engineering which cannot be controverted. And further, I would say that the test of this same engine was made on its every-day duty without any preparation whatever, as its daily duty was such as to make it imperative that it should be started at 3 P. M. and run until 6 A. M., which would necessarily preclude any preparation to favor the result. This had been the daily running condition from its first starting up, on November 27, 18~9, until the test, July 13 and 14, 1890 ; therefore I can very well say that this test faithfully represents the average daily running duty of this engine, and up to this time has not been equaled, to my knowledge, either by a two-cylinder compound or a high-speed type.

The record of this triple-expansion engine has since been excelled by one of the same type, but of the upright pattern, at the Harrison Street Pumping Station, Chicago, where well-authenticated figures show an indicated horse-power for a consumption of less than 12.7 pounds of water pumped into the boiler, and without any allowance whatever for leakage or moisture. When the duty of an engine is reduced to coal or water per indicated horse-power per hour, it is of course immaterial whether the load is generating an electric current or pumping water.

Reference is made to triple-expansion marine engines as a step in the wrong direction, which is about on a par with other statements made by the same authority. It is true that a triple-expansion marine engine does not reach the same degree of economy as a three-cylinder shore engine, for the reason that the ratio of expansion is not carried to such an extent, as it is imperative that all cylinders should develop their maximum power, with a result that their economy is about equal to that of the two-cylinder land compound ; at least such is my conclusion after a careful comparison of many records.

In order to still further reduce the coal consumption, there have been a number of quadruple-expansion engines built this past year, and it is not considered to be business principles to invest such large sums of money for machines of this class by steamship officials without an adequate ground for immediate return on the investment. The economy of the engines of the steamship referred to in the article as being made by the "professor" was evidently of the two-cylinder type, as the duty realized for this class of compound marine engines compares very closely with a single-cylinder steam-jacketed shore engine for the reason above referred to, and is clearly set forth by the writer in a paper read before the New England Cotton Manufacturers' Association at their meeting held in Boston.

To Mr. Thos. A. Edison justly belongs the honor of practically solving the problem of commercial electricity, but I cannot concede to our friend the claim that the high-speed engine was the pioneer engine that gave commercial electricity its first start, thereby enabling it to get a foothold, in the broad sense which our friend intended to convey to his readers ; neither do I believe that he could conscientiously say that, if it had not been for the Armington & Sims and other allied engines, commercial electric lighting would not have reached its now vast proportions.

The connection of the high-speed engine type with electric lighting was in its infancy ; the problem was to impart a rotary motion to the dynamo with a minimum of floor space, first cost and the ease with which it could be put in service, and the matter of economy was of secondary consideration, and, in fact, I surmise, left out entirely. Therefore, I think our friend must have a very high opinion of his pet type of engine and theory when he states that the high-speed engine has been the stepping stone to civilization and a "means of improving the standing of mechanics, materials and engineers." For engines were built many years ago which were fine examples of engineering and with a record of producing an indicated horse-power for about one-half the fuel that is commercially required for our friend's type of engine. I will admit that a high-speed engine requires good materials and workmanship to be run successfully ; so does a sewing machine, a rational speed engine, a lathe or a milling machine ; they all have a mission to perform which can only be successfully accomplished by the adaptation of each to the duty required of it.

Our friend appears to be laboring under the impression that, because the triple-expansion engine has from necessity come to the front (and it is to remain) with its three cylinders and connected parts, it must of necessity be dangerous, as he don't know which end is to kick first and cause the trouble ; and to ease his mind, and for his information, I may record an instance of a Corliss engine which had been run constantly, a short distance from New York, where no repairs had been made to the valve-seats of the engine for twenty years, and at the time it was reported, the valve faces were as smooth as a mirror and apparently as steam-tight as two iron surfaces could be made. This is but one example, and I should like to learn of a like case of a piston-valve that would remain reasonably tight for a period of two years.

There is one portion of the article which is quite right, namely, that the armature of the coming dynamo or generator will be connected direct to the engine shaft ; but the engine of the future for running the dynamo will be of the automatic cut-off type and will not exceed 100 revolutions per minute, thus admitting of a first-class economical engine, not exceeding in duty 14 pounds of steam per indicated horse-power and not, as our friend hopes, 200 revolutions and 18 inch to 20 inch stroke. Such a type of engine as indicated by our friend would preclude the highest degree of economy, which is so desirable at this time. Therefore I hope that the friends of the one gas-holder principle will look twice before they install ten or fifteen engines of the high-speed type, with their little army of attendants and "multiplicity of parts," into their station, when two slower engines may do the same work more satisfactorily and with far less fuel, supplies, attendance, etc.; for we can better afford with far less risk to place our dependence upon the mechanical disaster of a slow-moving engine, which so troubles our friend, rather than suffer a financial disaster, often met with in the high-speed type station.

Proceeding still further, we are advised that if we cannot put in a compound condensing engine of 200 revolutions we should, if water of condensation cannot easily be obtained at small expense, put in a direct-acting engine. This gratuitous advice is possibly offered with the belief that it costs a large proportion of the operating expenses to get that water into the condenser and an equal amount to get it out again, so that, take it all in all, you might better buy one of my high-speed engines, and save all of this useless expense and trouble, and pay the bills as they come in.

Take the article from beginning to end I cannot conceive of a more laborious endeavor to prove that "Carleton's" engine (the high-speed type) is the missing link between the most hopeless case of bankruptcy and a 10 per cent. dividend, and it certainly must be very pleasant musing upon one's return to the family fireside after a laborious day's duty to believe that such a mission has been so admirably fulfilled; and possibly it is equally pleasant to those who have the slow-speed compound type to know that their arc lights cost for fuel less than one-half those of our high-speed friend's.

If a man's mind is satisfied in this world, the road to happiness and comfort is smooth; and it is only when he gets away from home and compares notes with others that he realizes that other people are in better shape than he, and thus starts to thinking, that his trouble commences.

"ONE YEAR'S READING."

J. P. M., of North Adams, Mass., writes us under date of Dec. 3, "Enclosed please find money order for subscription for coming year. For some time past I have been an eager student of electricity, and deem it but just to say that never during any experience in my search for electrical knowledge have I progressed so well as I have during one year's reading of THE ELECTRICAL ENGINEER."

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EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. XII. NEW YORK, DECEMBER 9, 1891. No. 188.

Everything is possible with wave motion.—Nikola Tesla.

GOVERNMENT CONTROL OF THE TELEGRAPHS AND TELEPHONES.

TO some people this may seem to be a far-away subject, not likely to come within the range of practical politics for another ten years. Our own impression is that its appearance on one or other of the political platforms will take place at an early date. There is a growing volume of discussion on the matter, not over-intelligent, perhaps, but still very forcible when it comes to an expression in favor of governmental control; and at each widening of the area of interest and controversy, the day when a national vote will be taken to settle the question is brought nearer. At the present moment, we have a Postmaster General who makes Government Telegraphs the burden of his song; and while the public is given to understand that Mr. Gould opposes the proposition, there are some cynical people cruel enough to say that he and Mr. Wanamaker are *au fond* affectionately in accord even to the extent of a new scheme of addition, division and silence. Mr. Wanamaker has talked loudly about Government competition, but he knows that the American nation is honest and would not allow spoliation and confiscation. Mr. Gould says he prefers private management, but is that any reason why the Western Union would not sell out for $200,000,000? After all it is quickly narrowing down to a question of price, and that the price for all the telegraphs and telephones will reach $400,000,000 will soon be seen to be near the truth.

Under these circumstances, it is fortunate that the status of the Government telegraphs of Europe should have come up for such thorough and lively discussion as it did at the Electric Club last week, when Mr. E. Rosewater, editor of the *Omaha Bee,* lectured on his recent investigations abroad. There was little of the argumentative about the admirable and public-spirited lecture, Mr. Rosewater assuming wisely that his hearers were familiar with what may be termed the constitutional and political aspects of the matter. The pith of Mr. Rosewater's contention will be found in his statistics, and we imagine that he is willing to stand or fall by them. In other words, if we can get 20-word messages for 10 cents and have a telegraph office in every hamlet in the country, he believes that the old fears as to the development of paternalism will go for naught. He is probably right, but we are among those who regard that fear as very wholesome and something to be cultivated.

Coincidentally with the publication of the report of Mr. Rosewater's lecture in the daily papers came the annual report of Postmaster General Wanamaker, who has now gone so far on the road to the realization of his hopes that he actually sees 10-cent telegrams and 3-cent "telephons" among the near possibilities. One passage of his report is very striking:—

> "A year from next March," he says, "the telephone patent expires, and, unless Congress acts promptly to authorize its adoption for communication among the people, it requires no stretch of the imagination to believe that in the next two years one immense syndicate will unite and control all the hundreds of telephone plants of the country as the telegraph is now controlled, or the two will be united, and then for the next 20 years the most astute attorneys will be legitimately earning large salaries in indignantly opposing the so-called attacks of future Postmasters General upon defenseless vested rights."

This is pretty plain speech, but as we have intimated Mr. Gardiner Hubbard and Mr. Jay Gould—like any other men with such property—will be quite willing to turn over their holdings to the Government—for a consideration.

But before we get Government telegraphs and telephones, what a blessing it would be to have a half-way decent postal service. The report of Postmaster General Wanamaker devotes considerable attention to the condition of affairs in the postal service in and about the city of New York. His observations but serve to emphasize the pressing need which is well known to exist, of a radical reorganization both of the local and general service. We are glad that the wretched condition of affairs which now obtains, has at last received official recognition, but we cannot agree with the Postmaster General as to the most effectual remedy. The present post-office is in the right locality, although the edifice is grievously ill adapted to its present purposes, or for that matter, to any other purpose. Postal experts are substantially agreed that what is required to place the service on a proper basis is a metroplitan organization, embracing New York and its suburbs, to be placed under a single responsible official with as many subsidiary officers as may be necessary, the different points in the system to be united, not by a costly and undesirable system of "pneumatic tubes," as suggested by the Postmaster General, but by a modern electric dispatch of the portelectric or some equivalent type, the practicability and maximum cost of which have been thoroughly demonstrated. With such a system, for example, a carrier containing 10,000 letters could be dispatched to Brooklyn once in ten minutes if required, occupying less than three minutes in transit, and requiring the services of nothing more than a little 10 h. p. steam engine and one or two attendants to run it. The same plant might in the intervals send a carrier to the Grand Central Depot in four minutes and to Jersey City in half that time. This, be it remembered, is not a remote possibility, but an accomplished fact. In view of what has actually been done in electric rapid transit, the proposal to make use of pneumatic tubes for postal work, at this late day, seems little less than absurd, and ought not to be entertained for a moment.

THE EICKEMEYER-FIELD RAILWAY SYSTEM.

THE history of an art is no less interesting and valuable to the student than its current progress and this is especially the case just now with the electric railway. For those who have followed the successive changes which have marked the late advances of this rapidly extending application, the history of the Eickemeyer-Field system, as described in another column, will be of more than ordinary interest. Eickemeyer and Field evidently recognized very early the necessity of reducing as much as possible the gear between the armature shaft and the car axle, and the development from the belt transmission employed at the Chicago exhibition in 1883 on "The Judge," to the present type of direct-connected motor, marks the important stages through which the electric railway has passed since its first practical application, scarcely ten years ago. As one of the pioneers of the electric railway, Mr. Stephen D. Field certainly deserves credit for having so early discerned the necessity for the reduction of gearing.

THE USE OF SMALL MOTORS.

"OF course the prospectus tells us about America, and we are always glad to receive any scientific information from that country and to pick up practical hints, but when we come to commercial matters and prices, we may be thankful that our conditions of life are so widely different that no useful comparison can be drawn." We quote the above remarkable sentence as embodying one of the arguments which the London *Electrician* brings forward in a recent editorial to prove that any motors running nine hours a day and yielding more than 4 h. p. cannot be used unless under very exceptional circumstances. Our contemporary goes even so far as to say that "if a shop were opened in, say, Queen Victoria street, for the free presentation of motors to any one who would undertake to make regular use of them in their business, we doubt if the demand would be so great." It would be needless to go over all the well-known arguments which have been proved correct to demonstrate the advantage, in every way, of the electric motor for powers far exceeding 4 h. p., which our contemporary places as a limit, but the reason why American practice should be no guide to the English engineer in this respect is beyond our comprehension. So far from placing the limit at 4 h. p., we know of more than one instance where 30 and 40 h. p. in motors is being economically applied. As time passes, we note a steady increase in the size of motors employed in isolated installations deriving current from central stations, and this is so well recognized by central station managers that they are continually pushing for this very business. As the economy of station operation is becoming greater and greater, with a consequent reduction in the cost of current to consumers, the motor finds a larger field of employment, and we believe we are not deceiving ourselves, and, in fact, base our opinion upon authentic data, when we assert that within a comparatively short time the electric motor of any size will be more economical to operate for ordinary isolated power uses than any means of power located on the premises.

ELECTRIC LIGHTING AT ST. JOHN, N. B.

WHILE the many opportunities presented in this country might well be expected to occupy the energies of those engaged in electrical pursuits, it is natural that as time goes on, the field for American enterprise and apparatus abroad will enlarge. A few weeks ago we described the successful operation of an American electric road in Italy, and now comes the news of the successful starting of another at Leeds, England. In the same way, our recent articles on American electric lighting plants at Havana, Cuba; Kingston, Jamaica, and Barranquilla, U. S. C., are now followed up in this issue by a very full illustrated description of the fine plant at St. John, New Brunswick. In this instance, again, it is American capital and American apparatus that have been employed, and the results are already of the most hopeful and promising nature. Messrs. Zebley and Knudson are to be felicitated upon their intelligent enterprise, which we would be glad to see imitated elsewhere. There are many other places where this success could be repeated, and where in conferring an enormous benefit on the community, the promoters put themselves in a position to reap a rich reward from their foresight and courage.

The Æsthetic Side of Gerricide.

IT is expected that another New York criminal will soon be escorted to the chair of electrical execution, or as it might more strictly be called "the electrical spit." One of our recent correspondents has not unnaturally been reminded by gerricide and by the experiments attending it, of what he read as a boy in *Fox's Book of Martyrs*, as to the broiling of heretics, and the other sports of that nature with which they who were sound in the faith were wont to relieve the monotony of dull afternoons in the Middle Ages. Mr. Dodge took the ground against gerricide that, while it may not make a mess in the prison, it is *uncertain*. We still think it is open to both objections. The very fact that Dr. Southwick proposes to conduct experiments as to the behavior of raw meat when violently shocked, shows that gerricide does not leave its *corpus vile* in an æsthetically pleasing condition. As to its uncertainty, we have not simply the medieval practice of broiling, but the primeval practice of killing half-a-dozen innocent victims, who may perhaps serve as escort to the gerricided criminal, but are really intended as proofs that the apparatus for the main tragedy is in running order.

THE LAW OF MAXIMUM EFFICIENCY OF ELECTRIC MOTORS.

BY

C. O. Mailloux.

In the very interesting article on his new method of operating motors, published in the ENGINEER of Nov. 25, Mr. H. Ward Leonard enunciates a so-called new law of efficiency which is, unfortunately, not free from objections.

Mr. Leonard states his "law" as follows:

> "Vary the voltage as the speed desired,"
> "Vary the amperes as the torque required."

The now classical researches and historic experiments of Marcel Deprez have long since consecrated these two statements, which are to be found, more or less amplified and elaborated, in the writings of Du Moncel, Froelich, Ayrton and Perry, Silvanus Thompson, and others. The claim to novelty evidently rests upon the "combination", or rather, the opposition of the two statements to make a law. It so happens, however, that the combination does not formulate *a* law, but merely states, somewhat awkwardly, some of the conditions favorable to *the* law—Siemens' law of efficiency. The awkwardness and vagueness of diction is made readily apparent by the fact that a good illustration of the "law," as worded, obtains in the now common practice of regulating street car motors by means of a variable resistance in the circuit. The manipulation of this resistance at the time of starting, or afterwards, *causes the amperes to vary as the torque* required. It also causes the *voltage* (available at motor terminals) *to be varied as the speed desired.* This example strictly conforms to the *letter* of Mr. Leonard's law of efficiency. That it does not conform to its *spirit* as well is shown by the deprecatory manner in which Mr. Leonard himself refers to the efficiency obtained and obtainable in such cases.

While the law is evidently more general and far reaching, in certain directions, than its author intended, in other directions it does not reach as far as might be desired or expected. Mr. Leonard furnishes a good illustration of this deficiency, though apparently without noticing that he has, in so doing, wandered from the territory "covered" by his rule. He says:

"If we have a train of, say, three cars, so that we have six motors, we can start from rest with sufficient smoothness by placing all six armatures in series, which will give us something less than one-sixth speed as the first step. Then we can place three in series with two multiples, which gives us one-third speed. Next, two in series with three multiples, which gives us full speed. Under such conditions we can dispense with the small converting plant altogether."

It is scarcely necessary to point out that in this case the torque and speed are both varied or regulated, not by following Mr. Leonard's "law," but by varying the *counter-electromotive force.* The circuit-potential available to the motors may remain constant. The current, on the contrary, will not remain quite constant for all groupings. It is apparent, therefore, that Mr. Leonard's law would be most useful when supplemented by a key to, or list of, its exceptions.

The present writer sees no necessity for discovering new laws to replace the one law of efficiency (Siemens') which we already have, so long as this law is found sufficiently comprehensive and general to include and cover, satisfactorily, all cases yet referred to it. According to this well-known law, the efficiency (K) of an electric motor is the ratio of its counter E. M. F. (e) to the direct E. M. F. (E) of the current supplied to it, or, algebraically,

$$K = \frac{e}{E}.$$

A mere glance at this equation suffices to show three ways in which the efficiency (K) can be enhanced in any given case. 1. By lowering E. 2. By raising e. 3. By doing both simultaneously. These might be called the three *conditions* which influence efficiency, and might be embodied in the following rule which is a corollary from Siemens' law.

"Vary either the direct or counter-electromotive forces, or both, so as to keep them at all times as close to each other in value as possible."

Mr. Leonard's apparatus and his "law" conform to this rule by taking advantage of the *first* condition. The case quoted of the six motors variously grouped corresponds to the *second* condition. He gives no instance of methods corresponding to the *third* condition.

The present writer first realized the bearing and importance of the above "conditions" in 1886. In 1887 he operated a storage battery car in New York City in which the speed regulation was effected partly by grouping the batteries, partly by grouping the two motors, thus taking advantage of *all three* conditions. The car operated by the writer in Washington in 1890 was also regulated in a way to profit by all three conditions.

The writer has also tried the plan of regulating by using a motor whose speed is reduced by means of gearing adapted to giving widely variable speed ratios. In this case the torque is largely, or wholly, independent of the current, being governed mainly by the ratio of speeds. The regulation is effected by the counter E. M. F. lowering or rising according to the current needed for the work to be done, (condition 2). This method, though not yet reduced to the desirable simplicity or perfection of mechanical form and feature, is, nevertheless, a promising one, and likely, on the whole, to furnish us eventually the desired constant efficiency under varying loads and rates of work in a more simple and less round-about manner than is the converter method of which Mr. Leonard's is the prototype.

Without pretending to discuss here the merits of Mr. Leonard's ingenious method and arrangement, which doubtless will not be without its sphere of applicability and usefulness, it is perhaps interesting to point out that in the case of an electric car, a continuous current converter such as described by Mr. Leonard, would add some 1,500 pounds, and *two commutators* to the car. The objections to the two extra commutators would "weigh" if anything, *more* than the double machine. The writer has himself devised methods of regulation employing continuous-current converters in connection with ordinary *series-motors.* He has always been too diffident and timid, however, to broach the question of the two extra commutators either to the street railway manager or the motor-man, both of whom would more willingly entertain a proposition to reduce, instead of to increase, the number of commutators.

One of the interesting and important conclusions to which the study of the equation of efficiency leads is that there can be no efficiency unless there is a counter E. M. F. (*i. e,* when $e = 0$, then $K = 0$). Now, since we have no commercial way of causing counter E. M. F. in motors except by motion of the armature, it follows that when the motor is not in motion, we have usually $e = 0$, and the efficiency K, consequently $= 0$. This consequence is one from which no system of continuous-current motor operation is exempt. One can, it is true, reduce E to the lowest value needed to produce in the motor the current necessary for the torque desired. The energy thus spent ($E\ C$) is what Marcel Deprez designated some years ago as the "cost of the torque (prix de l'effort statique)." This "cost of the torque" always corresponds, as shown by Deprez, to the $C^2 R$ loss in a series motor. It practically does also in other motors.

The writer may take some future occasion to describe some of the methods of regulation proposed and tried by him in his endeavors to comply with the above conditions, influencing efficiency.

REACTIVE COILS.

BY

Otis K. Stuart

SINCE the sudden and comparatively recent enormous expansion of alternating electric lighting commercially, the writer has been asked by scores of persons to explain the "principle" of reactive coils. As these requests have most frequently been made by superintendents of central stations and others directly interested in the operation of alternating current apparatus, it is believed that a brief explanation of the actions of such devices will be of interest and value to not a few readers.

An alternate current transformer consists usually of a magnetizable core around which are placed two coils of conductors, having no electrical connection with each other or with the core. If now we pass a direct or continuous current of electricity through one of these coils, the appreciable effects to be noticed will be, first, the magnetization of the core, and second, the heating of the coil through which the current is passing. The lines of force will retain the same direction or polarity so long as the current is maintained in the same direction in the coil; but if the direction of the current be changed, the lines of force in the field will be found to be directed oppositely to the previous lines; and if we again change the direction of the current in the coil, the lines of force will again take the direction or polarization they had at first. If we alternate the direction of flow of the current in the coil, we thereby alternate the polarity of the magnetization of the core.

A principle enunciated by Faraday was that if a conductor be moved across or through a magnetic field, a current of electricity would be generated in the conductor; it was Prof. Elihu Thomson, I believe, who first stated the principle backwards—that if a magnetic field cut or be moved across a conductor, a current of electricity would be generated in the conductor.

In the case of the apparatus above mentioned, we have a stationary field of magnetism, except at the very start of the current, so long as a continuous current is maintained; and consequently no current is developed in the second coil except at the very instant of start of the current through the first coil. When the direction of the current is changed, there is another instant of moving field, and another impulse of current is sent through the second coil. And if these alternations are very rapid, the second coil will receive correspondingly rapid impulses of current alternating in direction, as is the case with the secondary coil of an alternate current transformer. These impulses of current in the secondary coil not only alternate with the alternation of the current in the first or primary coil, but each impulse of the former is found to be in the direction opposite to the corresponding impulse of the latter. That is, an impulse of primary current generates a magnetic field which sets up a current in the secondary, of opposite polarity to the primary current.

We are now ready for our reactive coil. In its simplest form it consists merely of one coil of a conductor wound around a magnetizable core. A direct or continuous current sent through this coil would simply magnetize the core and heat the coil itself. Reversing the direction of the current in the coil would apparently have the effect merely of reversing the polarity of the magnetism in the core. But we have here a moving field of magnetism in proximity to a conductor, and this moving field *must* act upon the coil, and in a manner opposite to the original impulse of current. The one coil serves as both primary and secondary of a transformer. The counter effect in the coil is named a counter-electromotive force, and it acts as a block to the progress of the first or primary current. The primary current in the coil generates a moving magnetic field which reacts upon the coil, setting up a counter-electromotive force, and cutting down the current in proportion. In the case of direct or continuous currents which are sent through the coil first in one direction and then in another, the counter-electromotive force is but momentary at the very start of each impulse of current; but with rapidly alternating currents the counter-electromotive force is evidently as constant as the impressed electromotive force or primary current.

A reactive coil placed directly in the circuit of an alternating system, therefore, can be made to control the amount of current going over the system, and this is its chief use. Specially designed reactive coils are used constantly by the Thomson Electric Welding Company for controlling electric welding transformers, and similar devices are familiar to all electrical engineers. But probably the most interesting application of this valuable apparatus has recently been made by Mr. Elias E. Ries in the Ries regulating socket, which is now attracting so much attention.

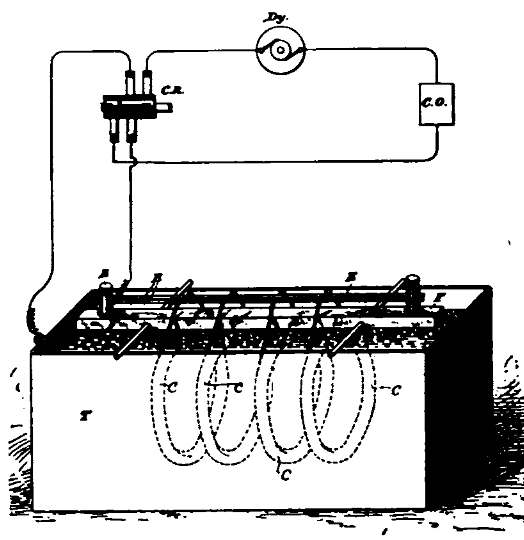
In this socket Mr. Ries has simply placed a very small reactive coil so connected to a series of contacts that, by means of a movable arm attached to an ordinary socket-key, a relatively small or large amount of current may be admitted to the filament, and the brilliancy of the light thereby governed at will. An incandescent lamp, on an alternating-current circuit, is thus placed upon an equal footing with gas, so far as the power of governing the light of individual burners is concerned. And that the method is very economical will be evident to any one who reflects that if the current does not pass through the coil, it is not used; in fact, is not generated. The total energy consumed in the lamp would be represented by the product of the voltage and the current actually supplied to the filament. And this is true in all other cases where reactive coils are employed as regulators.

VARLEY'S METHOD OF TESTING INSULATED WIRES.

IN covering electric conductors it frequently happens that particles of dust or other foreign matter lodge upon the insulating material or otherwise become incorporated within it, or that the material itself contains fine cracks or irregularities in thickness which lower its insulating power. A very large percentage of wires after being coated contain such faults, and it is a great desideratum to be able to locate them expeditiously and efficiently. Various modes of testing have been resorted to; but many of them require too much time for use where a large number of coils of wire are to be tested. Recently, however, Mr. Richard Varley, Jr., of Englewood, N. J., has devised a method, called by him the "flash test," which is based upon the fact, discovered by him, that if an insulated wire be connected to one terminal of an electric circuit the other terminal of which is placed in close relation to the insulating covering throughout its length, and the circuit charged with a current of high potential, a flash will be exhibited at such points of the conductor as are within range of disruptive discharge.

Mr. Varley's arrangement consists in charging a circuit one terminal of which is connected with the wire to be tested, and the other placed in close relation to the insulating covering with a current of sufficient electromotive force to produce a flash at points where faulty insulation exists. The terminals of the circuit are brought into the proper relation to create the flash by surrounding the insulated covering with water before charging the circuit.

As will be seen in the accompanying illustration, *Dy* represents a dynamo, in the circuit of which is interposed a series of coils of insulated wire C C C, which are to be tested. A current-reverser C R is introduced to produce periodical reversals of current. One terminal of the circuit is connected to a binding-post B and the other electrically connected with the water in the tank T. The terminals of the coils are inserted between two metallic bars E E supported in posts on the wooden beam F, supported on the tank, the bars being electrically connected with the post B. Thus the circuit between the wire forming the coils and the



VARLEY "FLASH" TEST FOR INSULATED WIRES.

water is incomplete unless leakage should exist through the insulating covering.

If now the circuit be charged with a current of from fifteen hundred to two thousand volts, and the current-reverser operated, a flash will be seen in the water at such points of any of the coils where the insulating covering is insufficient to resist such a charge. The current-reverser is operated at about sixty reversals per minute. If after a flash is developed the current be continued, the insulation would rapidly be destroyed, and in order to prevent such a result a cut-out is included in the circuit, having a lagging contact which renders it inactive except when a deficiency in insulation in the wire being tested exists. A weight on the armature is adjusted so that it normally holds the testing-circuit closed. When the armature is tilted, the weight is thrown past the centre and holds the circuit open, thus acting as a cut-out.

The coils which show a flash are removed from the tank and the operation is repeated with the others.

THE BURNET ROSETTE AND SWITCH.

BY

H. W. Burnet

EVERY one who uses suspended incandescent lamps knows how troublesome it is to light them. One has to set down anything one may have in his hands, find the lamp, then stand on tip-toe, raise both hands, use one to hold the socket and the other to turn the key; then it is lighted. Now you sit down to read or write; but you don't stay there; you must get up and stop the lamp from swinging.

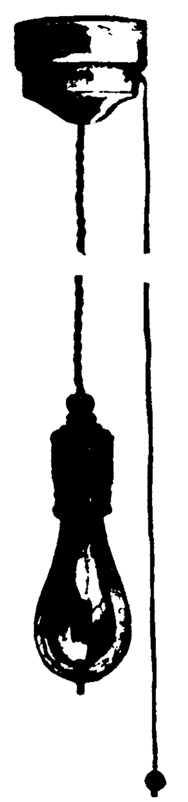
Appreciating these annoyances, the writer, some time ago, set about to design a rosette that would be as nearly perfect in design and convenience for wiring as possible, and that would be adapted to all uses to which it might be put, whether in dye-house or office, on cleat or moulding, and that would contain a switch which could be operated by a suspended cord arranged so as to hang below the lamp, where easily found and reached; or in convenient reach by seat, side of desk, near door, or anywhere else; and that could be operated by one hand. The lamp not having to be touched, would not be set swinging.

It was some time before a satisfactory switch that would answer the purpose was obtained, resulting in the simple and perfect-acting switch, illustrated in Figs. 1 and 2, and of such shape as readily to adapt itself to a rosette, socket and other uses. The switch has a quick make and a quick, long break, and after contact is once made there can be no separation until the complete break is made: a slight pull on the suspended switch-cord lights; a harder pull extinguishes, and one hand does the work.

The action of the switch is clearly shown in Fig. 3. It is composed of a double-spring arm, A, and a sector, B, made of some insulating material, with a metal-faced notch, N. A slight pull upon the cord C brings the hooked arm into this notch and completes the circuit. A harder pull brings the hook past the end of the sector and allows it to snap in the position shown by dotted lines, making an extra long, quick break. Releasing the pull allows the arm to come to the normal position, as shown, where it is ready to repeat its performance.

By arranging two sectors to face each other, Fig. 4, but with a suitable gap between, and putting a heavy cross-bar of good conducting metal on the end of the arm so as to bridge both sectors, and connecting the circuit to both sectors, thus not using the

FIG. 2.



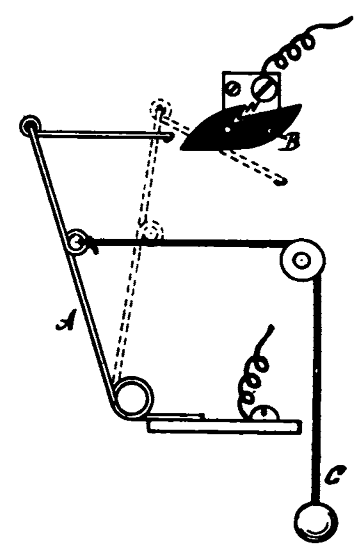


FIG. 3.

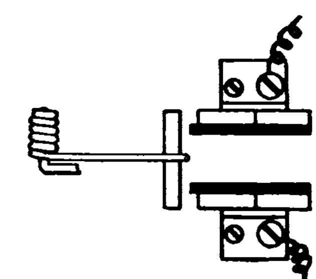


FIG. 1. FIG. 4.

BURNET ROSETTE AND SWITCH.

spring for the current, we have a switch for heavy currents on the same principle as that described above.

The complete rosette is shown in Fig. 1 and the cap and base in Fig. 2. It can be made in either wood, composition or porcelain, and can be used equally well for either moulding or cleat work. The switch may be put up either before or after wires are run and allows the wires to be drawn taut at any time after everything is in position. All connections may be made in the cap at any convenient time, and the caps afterward attached to the bases when they are in position. The switch is suitable for either damp or dry places, as it has a drip edge, and all connection are under cover. A simple method has been designed whereby the lamp-cord may be used as the pull, but this sets the lamp to swinging, which trouble it is desirable to obviate. It possesses a perfect action for a distant switch, and such switches are about to be designed for various currents. They will save the cost and trouble of running wires to convenient places for the ordinary switches.

An electrolier switch has also been designed by the writer which is enclosed in a bulb-shaped casting, threaded at both ends to receive the gas-pipe of the electrolier; a lever protrudes through a slit and a cord is attached to this. The cord has upon its lower end a ball or ring which may be pulled by the hand or with hooked pole, if out of reach. The cord may be brought over one or two pulleys to the side of room if desirable.

A SOUTHERN civil engineer writes us under date of Dec. 3: "If my humble opinion is worth anything, allow me to say that I consider THE ELECTRICAL ENGINEER a standard scientific journal that the electrical profession in this country should be proud of.

THE NEW THOMSON-HOUSTON W. P. MOTOR.

IN order to supply the demand for a compact motor equipment which should be adopted for narrow-gauge railroads, the Thomson-Houston Electric Company some time ago began the construction of a special equipment, in which particular attention was paid to the mechanical as well as electrical protection of the motor. This has resulted in what is known as the new "W. P.', (water-proof) motor, in which single-reduction gear is retained, and the construction of which is well illustrated in the accompanying engravings, Figs. 1 and 2.

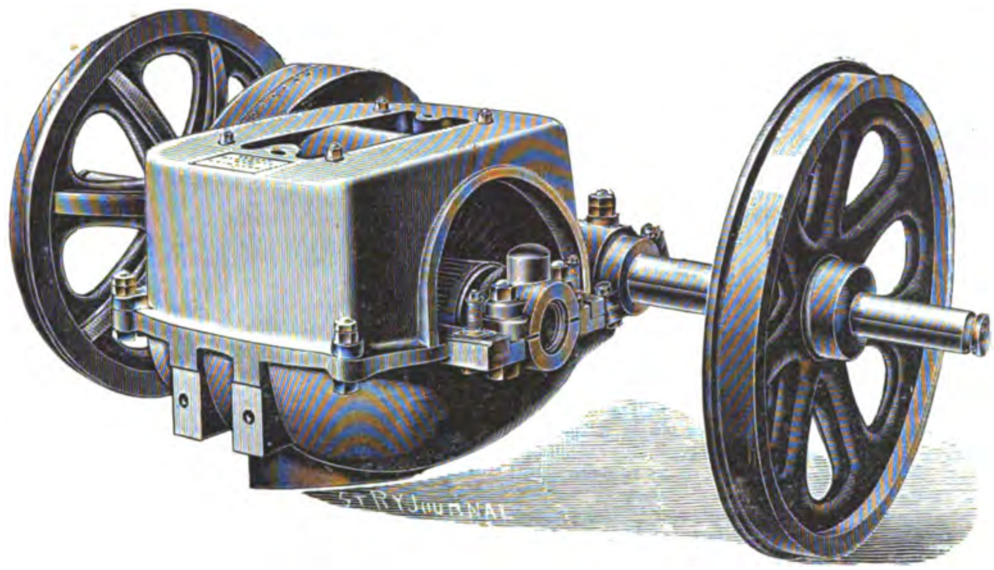


FIG. 1.—THE NEW THOMSON-HOUSTON "W. P." MOTOR.

The motor-frame consists of two castings of steel clamped together by bolts at the front and back, the axle brasses being held between the two parts. The armature bearings are cast in one piece with the lower half of the frame, and are provided with caps so that the linings may be inspected or renewed without disturbing other parts of the machine. The lower half is shaped somewhat like a bowl, rounding up from a plow-shaped bottom, which will throw aside stones or other obstructions which may be on the track. The engraving shows the upper half of the case raised. The upper half meets the lower, except upon the armature bearings, where holes are left for access to bearings and commutator and for ventilation. Only one field spool is used, which

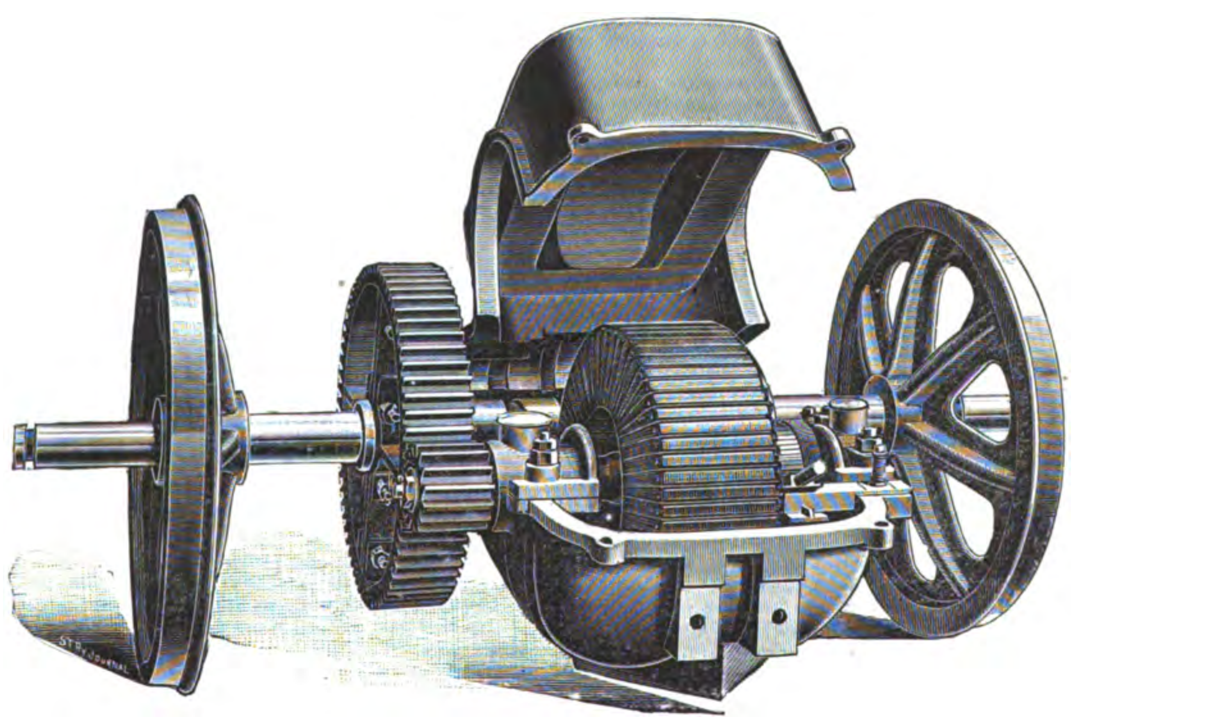


FIG. 2.—THE NEW THOMSON-HOUSTON "W. P." MOTOR.

surrounds the armature and upper pole-piece, and is itself completely covered by the frame.

A feature of this machine is the fact that it is so proportioned that at its normal load the solenoidal pull of the field is sufficient to lift the armature and relieve the bearing of its weight. There will, therefore, under ordinary conditions, be no tendency to hot bearings.

The motor can be run in water up to the axle—in fact, can be left standing in it without damage; and water dripping on it from above is shed off without gaining the interior of the motor. It will thus be seen that the armature, field spool, commutator and brushes are completely inclosed in the frame.

The parts of the frame are hinged together at the axle end. By removing four bolts, therefore, the upper half may be swung upward, or the lower half downward through a trap in the car floor or into a pit under the track, as may be convenient. The armature or field spool may then be easily removed.

Not only is the motor, as a whole, ironclad, but the armature is also ironclad. The core is a ring with projecting teeth of a peculiar form. The coils are wound between the teeth and held firmly in place by wooden wedges. No binding wire is used, and to replace a coil it is only necessary to drive out a wedge and the coil can be rewound without disturbing the rest of the winding. The winding is continuous; joints in the wire, where necessary, are electrically welded, no solder whatever being used. This construction protects the armature winding from mechanical injury as it is below the surface of the iron core. Electrically, a decided advantage is gained because the air gap can be made very small. This permits of comparatively few turns of wire being used to excite the field and consequently requires but a short magnetic circuit. It will be noticed also that practically all the metal in the machine is used in the magnetic circuit, thus making the weight of both iron and copper small.

The brush holders are mounted in a groove planed in the frame alongside of the armature bearing. By giving a quarter-turn to a handle on the brush holder, it may be taken from the motor to examine or renew a brush.

The armature shaft has been made short and heavy to avoid the possibility of springing and is fitted with steel shells, thus ensuring a proper bearing at all times. In case of wear from long use or scoring from grit, these shells can be replaced. The linings of the boxes are of punched sheet metal just thick enough to stand the wear required of them, and when thrown away waste little metal. The gears are of steel and are run in a case filled with oil. This case is split in halves and has a hinged cover through which the gears may be inspected and oil introduced. By loosening the nuts on two hinged bolts, a section of this case can be removed and the pinion on the armature shaft drawn off without taking apart the gear case proper. The small size of this motor permits two of them to be mounted on a truck of five feet wheel base and three feet gauge.

Although originally intended only for narrow-gauge roads, the "W. P." motor has performed such good service that it has been adopted by some companies as their regular service. Among others the West End Company of Boston, have tested it with the result that they have given an order for no less than 500 motors of this type to be used in the extension of their electric railway system.

ANNUAL DINNER OF THE ENGLISH ELECTRICAL ENGINEERS.

The annual dinner of the Institution of Electrical Engineers was held last week, writes our London correspondent. With the exception of the remarks of Prof. Crookes, the president of the society, the speeches were dull and pointless. I give you here a few of the sentences which the Professor uttered in proposing the toast of "Electricity in Relation to Science." He said they had happily outgrown the preposterous notion that research in any department of science was mere waste of time. It was now generally admitted that pure science, irrespective of practical applications, benefited both the investigator himself and greatly enriched the community. They knew little as yet concerning the mighty agency of electricity. "Substantialists" told them it was a kind of matter. Others viewed it, not as matter, but as a form of energy. Others again rejected both those views. High authorities not even yet agree whether we had one electricity or two opposite electricities. The only way to tackle the difficulties was to persevere in experiment and observation. The light which the study of electricity threw upon a variety of chemical phenomena could not be overlooked. The facts of electrolysis were by no means either completely detected or co-ordinated. They pointed to the great probability that electricity was atomic; that an electrical atom was as definite a quantity as a chemical atom. It had been computed that in a single cubic foot of the ether which filled all space there were locked up 10,000 foot tons of energy which had hitherto escaped notice. To unlock this boundless store and subdue it to the service of man was a task which awaited the electrician of the future. The latest researches gave well-founded hopes that this vast storehouse of power was not hopelessly inaccessible. Up to the present time they had been acquainted with only a very narrow range of ethereal vibrations. But the researches of Lodge in England and Hertz in Germany gave an almost infinite range of ethereal vibrations or electrical rays from wave-lengths of thousands of miles down to a few feet. Here was unfolded a new and astonishing universe—one which it was hard to conceive should be powerless to transmit and impart intelligence. Experimentalists were reducing the wave-lengths of the electrical rays. With every diminution in size of the apparatus the wave-lengths got shorter, and could they construct Leyden jars of molecular dimensions, the rays might fall within the narrow limits of visibility. They did not yet know how the molecule could be got to act as a Leyden jar, yet it was not improbable that the discontinuous phosphorescent light emitted from certain of the rare earths, when excited by a high-tension current in a high vacuum, was really an artificial production of electrical rays, sufficiently short to affect the organs of sight. If such a light could be produced more easily and more regularly, it would be far more economical than light from a flame or from the arc. By means of currents alternating with very high frequency, Professor Nikola Tesla had succeeded in passing by induction through the glass of a lamp energy sufficient to keep a filament in a state of incandescence without the use of connecting wires. He had even lighted a room by producing in it such a condition that an illuminating appliance might be placed anywhere and lighted without being electrically connected with anything. He suspended two sheets of metal, each connected with one of the terminals of the coil. If an exhausted tube was carried anywhere between these sheets, and placed anywhere, it remained luminous. The extent to which this method of illumination might be practically available experiment alone could decide. From Tesla's researches it appeared that a true flame could now be produced without chemical aid—a flame which yielded light and heat without the consumption of material and without any chemical process. To this end they required improved methods for producing excessively frequent alternations and enormous potentials. Would they be able to obtain these by tapping the ether? If so, they might view the prospective exhaustion of coal fields with indifference; they would at once solve the smoke question and thus dissolve all possible coal rings. Electricity seemed destined to annex the whole field not merely of optics, but probably also of thermotics.

THE GLOUCESTER, MASS., ELECTRIC STREET RAILWAY.

This road was started about five years ago with five miles of single track and five horse cars; eighty horses were used. After running with the above equipment for three years, three electric

Fig. 1.—Power House, Gloucester Mass., Electric Railway.

cars of the Daft system were added, and about a year later two more miles of track were laid; this summer another two miles of track were laid, making nine miles of track now in use.

In May last some motors of the Detroit Electrical Works' standard electric railway system, were added to the equipment, and later, enough more of the same system to make eight cars thus equipped. On Aug. 27 the formal opening of the road was made with a complete equipment of electric cars of the Detroit Electrical Works system operated by the single overhead trolley.

The power-house equipment now consists of one tubular boiler, Phœnix make, of New York; one tubular boiler, Roberts make, of Cambridge; one 125 h. p. engine, Phœnix; one 200 h. p. engine, McIntosh & Seymour; and two 80 K. W. generators, Detroit Electrical Works; a third generator of the same size and make has been ordered. The generators are belted direct from the engines.

The car equipment consists of eight 16-foot car bodies, eight 30

h. p. Detroit Electrical Works standard motors, and eight McGuire 19 B. steel trucks.

The road now runs from Rocky Neck through Gloucester to Bay View, Riverdale, Annisquam and Lanesville. During the summer months seven cars are run regularly, and on very good days all eight; during the winter, four cars are run regularly. The average mileage per car per day is 113; this is about what is averaged on most of the roads now using electricity.

In Gloucester there are probably more miles of crooked streets proportional to its size than in any other city in the Union; the view of Main street gives a fair idea of Gloucester streets in general. In the whole nine miles of track of the Gloucester railway there is only one straight stretch of one-third of a mile, and

FIG. 2. VIEW ON ELECTRIC ROAD, GLOUCESTER, MASS.

altogether there is probably not much over a mile; so there are nearly eight miles of curves. In addition to the curves there are many grades of from 3 per cent. to 9 per cent., and in four instances curves of short radius are located on steep grades.

During the last six weeks of the summer schedule seven cars were run regularly, and often eight; yet only two or three times was a car run into the car barn for repairs. It has often been said that a truck fitted with one motor geared to both axles and held rigidly would not run satisfactorily around curves. The record made in Gloucester effectually answers this statement, as the cars averaged 113 miles per day and did it in a perfectly satisfactory manner.

The current for the four cars which are now being run regularly is furnished by one 80 K. W. generator, which is driven by the 121 h. p. engine; the daily consumption of fuel is one and one-half tons of slack and one-half ton of Cumberland coal.

The number of passengers averaged daily for the four cars is 1,900; during the summer the number carried daily averaged 4,000.

The receipts per car show an "increase" for the last three months over the corresponding months of last year of twenty-five per cent.; the operating expenses, including interest at 6 per cent. on sixty thousand dollars (the cost of equipping with electricity) show a "decrease" per car of 12 per cent., allowing for the greater mileage which the electric cars make over that made by the horse cars; the operating expenses per car mile show a "decrease" of twenty-five per cent.

The above showing is certainly an excellent one, and speaks well for the "Standard" electric railway system of the Detroit Electrical Works.

ELECTRIC TRACTION IN EUROPE.

THERE can be no doubt, writes our London correspondent, that electric traction is attracting great attention in Europe at the moment, and it will be strange if some of the many schemes suggested are not executed. In addition to the proposals made in England, the Municipal Council of Paris has provisionally accepted the project of M. Berliner for an electric railway which will cross Paris at its greatest breadth. There are to be six stations, the generating machinery to be situated at the end of the line. In many respects the railway will be built after the model of the South London Railway.

While speaking of the South London Railway I might say that by an increase of the fares and the issue of season tickets the financial results at the end of the year ought to look better than they have ever done before, for the increased fare has caused little or no falling off in the number of passengers.

THE GOVERNMENT TELEGRAPHS OF EUROPE.[1]

BY E. ROSEWATER.

THE founders of our Republic conferred upon Congress the power to establish post-offices and post-roads. It is scarcely conceivable that it was their intention to limit the national legislature to the conveyance of the mails in post coaches running over wagon roads. The manifest scope of the constitution touching the exercise of the power to establish and maintain a postal system is to facilitate commercial and social intercourse between the people by the use of every device that will insure the speedy and economic transmission of intelligence. The century that has elapsed since Benjamin Franklin assumed charge of the first post office in the United States has witnessed the transition from the postal stage coach, the pony express and carrier pigeon, to the "fast mail" train drawn across the continent at the rate of a mile a minute; from the 60 days across the Atlantic" packet sail-boat to the "six days from New York to Southampton or Liverpool" twin-screw steamer. But our postal system cannot attain its full measure of usefulness and efficiency until the electric telegraph and long-distance telephone have been made an integral part of our postal facilities, with the pneumatic tube post as an auxiliary for conveying letters and messages in our great population centres.

Everybody familiar with the history of the telegraph knows that Professor Morse offered his invention to the Government for the paltry sum of $100,000, and urged the Postmaster-General to construct and operate telegraph lines as an adjunct of the mail service. It is also historic that the monumental mossback who occupied the position peremptorily declined the offer of Professor Morse, on the ground that in his judgment such a thing as transmitting messages from one point to another over a wire was preposterous and impossible. In due time, Professor Morse prevailed upon Congress to appropriate $30,000 for the construction of an experimental line of telegraph, and with this money the first wire built and operated in America was erected between Baltimore and Washington. So the telegraph at its very inception owed its successful introduction in America to the munificence of the Government, and by rights it should have been operated as a part or our postal system from the outset.

In 1862 Congress was again invoked to aid in the extension of our telegraph facilities. At that time the most rapid communication between the people east of the Mississippi and those on the Pacific Coast was by the overland stage and pony express. A bonus of $400,000, payable in ten annual instalments, was voted to the company organized to build the Pacific telegraph line. This extension of the telegraph across the continent, from the Missouri river to Sacramento, involved the construction of about 1,700 miles of pole line. The bonus of $235 per mile not only paid for the whole line, but left a very considerable margin. The promotors of the enterprise, within five years, realized three dollars for every fifteen cents they had actually invested. I have recalled these historic facts merely to disabuse the minds of many who labor under the delusion that our telegraph system, unlike that of other countries, has been built up entirely by private capital and individual enterprise. It is not my purpose at this time, to indulge in an exhaustive history of our complex system of telegraphs under corporate ownership. Suffice it to say, it is the natural outgrowth of promiscuous construction, wasteful competition, and reckless absorption. A bird's eye view of our telegraphs would present a dense jungle of poles planted and transplanted, and a bewildering network of wires strung and restrung by a succession of stock-jobbing speculators. As an inevitable consequence, the Western Union Company, which has swallowed more than sixty big and small competitors, is periodically overstocked with needless wires between great commercial centres, which usually offer the most tempting field for enterprising men who build lines to sell out, while there always has been a lamentable lack of telegraph facilities at small cities and towns that are made dependent entirely upon the congested railroad wires. Our telegraph companies never maintain an office where the receipts do not offset the expenses. Such a policy is not pursued in countries that possess postal telegraph facilities, because the Government is at no additional expense for rent, and postmasters in small towns and cities are required to perform the duties of telegraph operators.

Nothing has impressed upon me more forcibly the dangerous tendencies of telegraph inflation and over-capitalization than the comparative exhibit of the world's telegraph system submitted to Congress last winter by the president of the Western Union Telegraph Company. According to Dr. Norvin Green, this country has 185,000 miles of telegraph pole line, as against 375,000 miles possessed by all other countries of the world. There are 673,000 miles of wire in the United States, as against 1,111,968 in all other countries, and there are in America 18,000 telegraph stations, against 53,000 in all other countries. Mr. Green computes the aggregate number of telegrams handled in this country at a fraction over 60,000,000, while he credits

1. A lecture delivered before the Electric Club, N. Y., Dec. 3, 1891.

the rest of the world with handling 173,000,000 telegrams. As a matter of fact, the aggregate number of telegrams handled in European countries alone, computed officially for the year 1889, is 204,935,055. What do these figures show? With one-half of the world's telegraph line mileage, American telegraph companies should have handled one-half of the business. Instead of handling 102,000,000 telegrams, they only handled 60,000,000. With one-half of the world's telegraph lines in a country that boasts two-thirds of the railway mileage of the world, America should have her full quota of the world's telegraph stations; but out of 53,000 we only have 18,000, including railroad offices, which comprise nearly three-fourths of our telegraph stations. On the other hand, Great Britain, with less than one-third of the wire mileage of the United States, handled 63,403,399 telegrams in 1889. Do not these figures demonstrate that the periodic acquisition of lines built for speculation prevents the economic working of our system by clogging it with useless wires, and will always operate as a barrier to a material reduction of our telegraph tolls, because our telegraph companies adjust these tolls on the basis of a capitalization which at this time already includes from $40,000,000 to $50,000,000 of stocks and bonds issued for speculation plants.

Let us take a cursory survey of the Government telegraphs abroad. I trust that I violate no confidence in stating that before embarking for Europe last summer, I procured letters of introduction from Postmaster-General Wanamaker to the postmasters of England, France, Germany and Austria, coupled with a request that their respective departments extend to me the facilities for making an inquiry into the practical operation of their systems of telegraph. This investigation was a self-imposed task. I have for more than a quarter of a century been an outspoken advocate of the postal telegraph, and desired to see for myself how it worked in foreign countries. Upon presentation of my credentials, I was everywhere accorded the most courteous reception. The chiefs of the telegraph bureaus, telegraph engineers and superintendents, took pains to exhibit the operating rooms, instruments, batteries and appliances to me, explained to me the methods pursued in handling dispatches and freely answered all inquiries concerning construction of lines, subways, office regulations, number and qualifications of employés, working hours and wages. They also furnished me sample telegram blanks and official documents relating to the management, extent of plant and business done. The Hon. J. Cameron Lamb, general manager of postal telegraphs for Great Britain, favored me with an official letter to the postmasters of Manchester, Birmingham and Swansea, which enabled me to inspect the telegraph operating rooms and investigate the operation of postal telegraphs in those so-called provincial cities.

I will read you Mr. Lamb's letter which I was permitted to retain as a souvenir of British official courtesy:

To R. M. Johnson, Esq., Postmaster and Surveyor, Manchester; J. F. Wight, Esq., Postmaster and Surveyor, Birmingham; E. H. Oakden, Postmaster, Swansea.

DEAR SIRS:—The bearer of this note is Mr. Edward Rosewater, Omaha, United States. The postmaster-general desires that he may have full information regarding the telegraph work in your offices, and I am to ask that you will be good enough to allow him to see the operations actually performed and to afford him all necessary facilities. I am, dear sirs, yours very truly,

J. C. LAMB.

Similar courtesies were extended to me by the director-general of the German postal telegraphs, Dr. Haake, and Dr. Neubauer, director-general of the postal telegraphs of Austria.

The first step toward merging the telegraph system of Great Britain with the postal service was taken in 1868, when Parliament passed an act authorizing the purchase or leasing of all lines operated by private companies.

The proposition to establish a postal telegraph had been vigorously opposed by the telegraph companies at every step, and when the transfer was finally made, the government came into possession of a conglomerate system of lines which had been allowed to run down by the companies from the time Parliament had voted to take them out of their hands. The act of 1868 fixed the uniform rate of one shilling (25 cents) for a message of 20 words, exclusive of address and signature, and three pence (6 cents) for each additional five words, to all parts of the United Kingdom. This was a material decrease from then existing rates, and, as a natural consequence, the postal telegraph lines, in their wretched condition, were for a time inadequate to handle the increased business. This defect was, however, remedied as soon as the tumbled-down lines had been re-constructed and the old plant had been thoroughly overhauled.

In 1870-71 the number of messages handled by the British postal telegraph was 9,850,177. In 1874-75 the number had increased to 19,253,120. In other words, the number of telegrams handled had doubled within five years. In 1880-81 the number of telegrams handled was 29,411,982, another increase of 55 per cent. in five years, and in 1885 the number of messages handled had reached 39,146,283. By the Act of October, 1885, the rate on telegrams to all parts of Great Britain was reduced to six pence (12½ cents) for a message of 12 words, including address and signature, and one-half penny (one cent) for each additional word. This reduction was followed by an enormous increase of business. In the year 1886-87 the number of telegrams handled was 50,243,639, and in the year 1890-91, 62,403,399.

This vast volume of telegrams is handled by the British postal telegraph with promptness and marvelous accuracy, so far as I was able to observe. In London, the city messages are transmitted exclusively by postal pneumatic tube. The pneumatic tube department in the great central telegraph station handles the bulk of the letters, dispatches and cards that are delivered within the city of London. Outside of the London Exchange, which is supplied with an independent system of direct commercial wires, all communications within the city of London proper, are despatched by pneumatic tube.

Thousands of dispatches, letters and postal cards are literally shot by air pressure every hour of the day from the 20 postal tube stations located at the points most accessible into the Central Telegraph station, and there they are re-distributed and fired back to other stations, delivered by carrier or forwarded by telegraph or telephone to points outside of London. The longest of those tubes is that from the Westminster parliament building, through which the proceedings of parliament are shot to the Central Telegraph Office, and thence transmitted by wire to provincial cities or delivered to such London papers as may order duplicates.

The tubes have not only enabled the postal authorities to transmit the dispatches and city letters in London more rapidly than they could be forwarded by wire, but they have done away with the costly and inefficient local wire service and in a measure the pole and wire nuisance. But to the public, the greatest benefit of the tube system is its cheapness. In New York or Chicago a city message of ten words or less costs you 20 cents. In London you can send as many words as you can write on the blank or card, which varies from 100 to 1,000 words, for six pence (12½ cents), and, what is also important, your message will have been delivered almost before the girl who usually acts as operator in the hotels of local offices in our cities has had time to copy it. By the tube system no copying is done—the original message is delivered to the party to whom it is directed, unless it is to go by telegraph or telephone to points beyond London.

While London was the first city to utilize pneumatic tubes for the rapid transmission of mail matter and telegrams, the cities of Paris, Vienna and Berlin have for years been served by pneumatic tube post. During the year 1889 the pneumatic tube post of Vienna handled 2,692,752 letters, telegrams and postal cards. Of this number, 1,541,647 were telegrams. But the city of Berlin can truthfully boast the most perfect and best served system of postal pneumatic tubes in the world. While London has only 20 pneumatic tube stations, Berlin now has 51, distributed not merely over the entire area of the German capital, but reaching out into the suburbs. You may deposit your message in one of the pneumatic tube stations, and it will reach any point within a radius of 10 miles within six minutes, including a retransfer at the central tube station. For six cents and a half your message or letter inclosed in one of the red Rohr Post envelopes, will be fired through the tubes from Berlin to Charlottenburg, and delivered by postal carrier.

Berlin has about the same population as New York, but New York does four or five times as much business by mail or telegraph. But it takes from one hour to half a day to transmit and deliver a message by mail or wire from the City Hall to Harlem.

The Postmaster General of Great Britain was empowered by the Act of 1868, which authorized the acquisition of the telegraph lines, to facilitate the collection and transmission of dispatches by designating places for depositing telegrams in letter-boxes and other depositories, and telegrams deposited therein are, if written on stamped paper of proper value, conveyed by letter carriers to offices of transmission by wire or to the tube stations free of charge. This is a convenience that we cannot secure so long as our telegraph lines remain under corporate ownership. But the postal telegraph facilities in London, even without this special convenience, could scarcely be improved on. At the present time there are 538 stations in London from which telegrams may be forwarded. Of this number, 451 are branch post offices and 87 are railway station offices. Inasmuch as the telegraph tolls are uniform throughout Great Britain, parties simply purchase stamps covering the cost of any message and the stamped blank is rushed through the tube to the Central Station, and thence transmitted by wire to its destination. A telegram with the proper stamp attached, dropped into a post-office box in any city in Great Britain, will be wired from the nearest telegraph station just the same as if the sender had gone through the tedious formality of handing it directly to the receiving clerk at the telegraph office. For the accommodation of business men and other patrons who use the telegraph frequently, stamped telegraph blanks are supplied at a trifling extra charge for paper. Similar conveniences are enjoyed by the people of France, Germany, Austria and other countries of Europe.

It would be impossible within the scope of this lecture to describe in detail the great operating rooms of the capitals of Europe.

The largest telegraph office in the world is in the British metropolis, employing an aggregate of over 3,300 operators and clerks in one building. Of this number two-thirds are men. The female operators occupy a large and well-lighted hall in which the Morse instruments, with registers and paper reels, are used exclusively. Nobody is permitted to receive by sound; and this is also the strict regulation on all telegraph lines where Morse instruments are used in France, Austria and Germany. The main operating room in London is like a great machine shop, although not half as noisy as the main office of the Western Union in this city. All the most approved telegraph appliances are utilized. The English Wheatstone with modern improvements appears to have the preference. The Hughes printing instruments, perfected in England, are receiving greater appreciation in Europe than they do in America.

In Berlin the Hughes printing instrument has the preference, and one hundred of these are used in the central telegraph station. Delany's sextuplex, an American invention, has been in active use in London for several years and the inventor and patentee receives £2,000 or $10,000 royalty per year from the British Government. This fact affords sufficient proof that the Government telegraphs in Europe utilize all the inventions as rapidly as do the American private companies. The operating room of the Central Paris telegraph office is a rectangular hall with Gothic arch ceiling. The operating tables are placed to insure convenience for retransmission. The Morse instruments are in use on short circuits, and the Hughes printing machine operates on several lines, but the favorite instrument on the French telegraph is the Baudot. This is a printing telegraph operated by synchronic movement. The only skill required is in transmitting. The receiving is automatic, by paper roll three-fourths of an inch wide on which a message is printed. These printed slips are pasted on telegraph blanks delivered as they are received. The Baudot instrument has been perfected so as to operate duplex and quadruplex—this is, sending and receiving two or four dispatches simultaneously over one wire. The operating force in the main office at Paris consists of 550 men and 450 women. The day operators work seven hours and the night men ten hours. The night men receive larger pay and extra-ordinary pay after midnight. In France as in England the Postal Telegraph employees are allowed two weeks' vacation each year with full pay. At the central telegraph station in Vienna about 500 instruments are in use largely composed of Morse registers and Hughes printing machine. The Hughes instrument has been perfected by an ingenious Austrian electrician, and is now operated on several long wires as a quadruplex. The American plug switches supplied with wires separated into divisions, most in use in Vienna, are exceptional features. At London, Paris and Berlin the switches are altogether on a different model. At the Berlin central telegraph station no duplex or quadruplex instruments are in use, the Government having supplied an abundance of wires for the volume of business done.

One of the novelties introduced at Berlin is the use of an accumulator battery. This battery consists of 120 cells divided into three sections of forty each; only two of these sections are in use at any one time they operate. A steady current and no variation has been noted during the ten months that they have been in use. The German Government pay the Berlin Electric Lighting Company sixteen marks, or less than four dollars per month, for maintaining this battery, from which 300 wires are steadily supplied with electric current. The managers of the Berlin office pride themselves upon the fact that they have worked direct with Teheran, the Persian capital, a distance of 3,500 miles. A through line from Berlin to Rome over bronze wire works admirably and is now in constant use. The most commodious and magnificent telegraph office in all Europe at the present time may be found at Birmingham. The operating room in Birmingham is a new building recently completed by the Government. The room is a quadrangle 206 feet by 42, lighted from all sides and equipped with the most modern appliances and the finest test-board switches in all England.

This rambling survey of the great telegraph stations of the European capitals may be somewhat disappointing, but it is impossible within the limit of time at my command to enter into greater details.

The impression has prevailed in this country that the Postal Telegraph service of Europe does not afford as good facilities and cheap rates to the press as do the telegraph lines of America. This I have found to be erroneous. While the British Postal Telegraph does not permit preference in the transmission of dispatches to any patron, the press dispatches are transmitted over special wires. The efficiency of handling press dispatches in London surpasses anything I have ever seen. Reporters and correspondents file their dispatches, inclosed in special envelopes, directed to the Intelligence Bureau; they are immediately shot into the central Postal Telegraph building and transferred through a pneumatic tube into the Intelligence Bureau; there the envelope is opened, the dispatch checked, and at once transmitted by special wire, or by telephone, as the sender may direct. Press dispatches may be duplicated to any number of papers, and parliamentary proceedings and other general news is often wired simultaneously to from 200 to 300 papers. The Intelligence Bureau supplies leased wire service to leading dailies, and one may lease a wire for all night or for short periods at very reasonable rates. The London *Times*, Manchester *Guardian*, Liverpool *Courier*, and dailies in Edinburgh, Glasgow and Dublin receive the bulk of their telegrams by a leased wire. Charges for any distance in Great Britain for press messages are as follows:

For every 100 words between 6 P. M. and 9 A. M., 1s. (25 cents).
For every 75 words between 9 A. M. and 6 P. M., 1s. (25 cents).
For press dispatches sent to more than one address, 2d. (4 cents) for every 100 words in the night or 75 words in the day for each additional paper.

Computed for a service of 1,000 words a night, a special dispatch directed to one paper would cost $2.50; the same dispatch transmitted in the day to one paper would cost $3.33. But suppose that this service is to go to a press association of 10 papers, then the service would be for 1,000 words, night, $6.50 to the 10 papers; in the day to the same papers, $8.13. If the service is to go to 25 papers, then the cost of 1,000 words in the night would be $12.10, and transmitted in the day, $14.85. This is less than 1¼ cents per word night work, and 1½ cents for day work delivered to 25 papers. In other words, each paper in an association of 25 dailies would pay only 48⅖ cents for 1,000 words of night report and 59⅖ cents for 1,000 words of day report, while 10,000 words of night report would cost $4.84 and 10,000 words of day report $5.93 per day for each paper. This is certainly a lower rate than the most favorable contract any telegraph company has ever granted to the Associated Press or any other association.

The rate charged for leased wires in Great Britain is $2,500 per annum for a line extending to any distance within the United Kingdom, the service beginning at 6 P. M, and terminating at 9 A. M. for six nights in the week. The Government furnishes the operators and instruments. Leased wire messages are delivered free at newspaper offices at a distance of one mile from the main office. Special wires can be extended into newspaper buildings by the payment of additional rental computed on a distance basis which would be very trifling. In this country the wire rental is computed at $10 per mile. A line 200 miles long would rent for $2,000 a year, and the paper leasing the same would have to pay for the operators, which would incur an additional outlay of $2,000 per year. A line between New York and Cleveland, a distance about the same as that between London and Glasgow, would cost $6,000 a year for wire rental and $2,000 for operators, as against $2,500 charged for the same service in Great Britain. The press service receives special care at the Paris central office and the leased wires service is even more liberally arranged in France than in England. You can lease a wire for an hour and even for five minutes. The rate for one hour over a wire extending any distance within the Republic of France is 30 francs or $6, including operators' service at both ends, or 2½ francs, or 50 cents for five minutes. The average transmission is 2,000 words an hour, and often with very rapid printers, 300 words in five minutes. International wire service is necessarily dearer. There are, however, several international wires leased to newspapers and Press Bureaus. The *New York Herald* has a leased wire for certain hours between London and Paris, and the Reuter and Havas Correspondent Bureaus have several wires leased which are operated by them for the transmission of International Press news analogous to the Associated Press reports. The French Postal Telegraph grants a rebate to the press for the time during which a leased press wire is in use for commericial purposes. When the press has leased wires and the Government uses them in the interval when they are not in use for press dispatches the expenses are shared in proportion to the service.

In Austria the bulk of all press dispatches is transmitted by long distance telephone, which is part of the Postal Telegraph plant in that country. This is also true of Germany. All the press dispatches between Vienna to Prague, a distance of nearly 300 miles, are transmitted by telephone at rates computed according to the time consumed.

The salaries of Postal Telegraph employees in Great Britain will compare favorably with those paid for the same class of operators in this country, barring perhaps a dozen officials of the highest rank. The pay-roll of the British Postal Telegraph embodies:

	Annual salary.	Annual increase.
1 Engineer-in-chief	$6,000	$250
1 Assistant and electrician	4,750	125
1 Submarine supt. at Woolwich	3,500	125
1 Superintending engineer	3,500	125
1 Assistant supt. engineer	2,250	125
13 Supt. engineers	3,000	
31 First-class inspectors	1,400	
64 Second-class inspectors	1,050	

LONDON CENTRAL TELEGRAPH STATION.

Male Staff.

1 Controller	$5,000
1 Deputy	3,750
2 Assistants	2,500
19 Chief operators	2,000
52 Assistant chiefs	1,550
48 Second-class chiefs	1,500
170 Senior operators	950
441 First-class operators	800
1149 Second-class operators	550

Female Staff.

1	Matron	$1,150
9	Supervising operators	900
18	Assistant supervising operators	700
40	Second-class operators	550
230	First-class operators, per week	9.50
521	Second-class operators, per week	7.50
53	Pneumatic tube attendants, chiefly boys, per week	7.50

This salary list should allay the groundless fears aroused among my former associates in the telegraph service, that postal telegraph would reduce them to starvation wages. Another feature of the British telegraph management is the retirement of aged employees on an allowance that places them beyond dependence. By the telegraph purchase act of 1868, all telegraph employees who had been in the service of the companies twenty years or more prior to the purchase, and failed to secure re-employment in the Postal Telegraph service, were to receive annuities equal to two-thirds of their salary, and if less than twenty years, the annuity was to be reduced by one-twentieth for every year under twenty, but no annuity was granted to any employee who had served less than five years in the telegraph companies' employ. In 1891 there were on the Postal Telegraph pay-roll the following ex-employees of the telegraph companies:

7 Chief Officers and Superintendents,
25 Inspectors and Linemen,
37 Clerks and 1 Messenger, or in all 70 persons.

There were also the following employees retired on account of old age or disability:

1	Engineer-in-chief	$4,000.
1	Controller	2,805.
108	Male Operators, £9,672 each	445.
67	other employees including linemen, messengers and laborers.	

This is certainly liberal treatment. The same policy is pursued in France, Austria and Germany. In the latter country, Postal Telegraph employees share with all other government employees the benefits of the system of life insurance and annuities after a long term of service. But the most striking feature of the government telegraphs in its relations to employees is the impartial promotion of every person according to capacity and merit and the assurance of employment during good behavior.

The tenure of office, or rather of employment, constitutes one of the most commendable features of government telegraphs and is the most potential safeguard against political interference with persons employed in this branch of the public service. "The greatest trouble we have," said the Director General of Telegraphs for Germany, "is to get rid of a man that makes himself offensively disagreeable. We cannot discharge a man who has been placed on the permanent employment roll after two years' probationary service, until he has been convicted of a criminal offense before a court under the same process that is prescribed for violators of the criminal code. We can fine him for neglect of duty or suspend him for a short time, but he cannot be dismissed from the service." In this country operators hold their places subject to the whims and caprice of officials often their inferiors in point of ability and no redress is afforded for the most glaring injustice.

Now a word about the political influences of the postal telegraph. My investigations were confined to four countries, England, France, Austria and Germany. France is a republic like ours, and party feeling is more intense there than in America. England is a constitutional monarchy, governed by party that holds its supremacy through electoral majorities. Germany and Austria are limited monarchies. In all these countries the response to my inquiries concerning political interference with telegraph employees, or abuse of power in tampering with messages, was uniformly the same. The chief operator of the Swansea (Wales) office declared most emphatically that he was a radical and decidedly opposed to the present Conservative party in power. He said also that a number of the operators in his office were either radicals or Liberals, but "if the postmaster who has supreme control of the telegraph force dared to dictate what ticket we should vote, or undertook to interfere in any way with our rights as citizens, we should soon have a Parliamentary inquiry, and the postmaster would soon find himself dismissed in disgrace." In Paris Mons. Magne, Director General of Telegraphs, expressed great surprise at my question about political interference with Postal Telegraph men. "We all exercise our rights as citizens untrammelled," said he; "Postal Telegraph men are not allowed to take an active part in campaigns or in public meetings, but all vote as they please." Such a thing as trying to delay a political message or tamper with it, or divulge its contents, has never been heard of in France. The attempt, if made, would cause a revolt and overthrow the party that was in power at the next election. The Director General of German Telegraphs was equally emphatic. He said: "There are quite a number of social democrats in the telegraph service. These men are virtually committed against our form of government, but we cannot interfere with them so long as they do not conduct themselves treasonably." In all European countries the laws against delaying or destroying telegraphic dispatches are much more severe than they are in this country.

It gives me great pleasure to be in a position to pay a high compliment to American telegraph operators. After careful inspection of the Postal Telegraph in the British metropolis, in Paris, Berlin, Vienna, Birmingham, Manchester, Hamburg, Prague and other European cities, I can truthfully assert that the most skilful telegraphers of the world are in America. One of our first-class operators does fully as much work in a given time as is done in London, Paris or Berlin by two operators. On the other hand, the European telegraphers as a class have a higher education and are fitted not only to manipulate instruments and transmit despatches but to supervise other branches of the postal service. In Germany telegraphers are classified from the outset into two classes; the first class is made up of men who have received a high school education before entering the service. This class receives the lowest pay and can only aspire to promotion within the telegraph service. The second class is made up from graduates of universities who are paid a higher salary from the outset, and are in line of promotion, as electrical engineers, superintendents, and finally postmasters in the larger cities. This feature has made the telegraph a stepping-stone towards important positions in the civil service that are directly or indirectly connected with the postal system.

Literature.

A Practical Guide to the Testing of Insulated Wires and Cables. By HERBERT LAWS WEBB, Member American Institute of Electrical Engineers and of the Institution of Electrical Engineers, London. *New York. D. Van Nostrand Company,* 1891. 12mo, pp. 118 + 8; 38 illustrations. Price, $1.50.

THE series of articles by Mr. Webb, which originally appeared in the columns of THE ELECTRICAL ENGINEER, have met with such favor at the hands of the profession, that they have now been republished in a convenient little volume, which cannot but prove highly acceptable to the large and increasing number of electricians employed in the class of work of which it especially treats.

Mr. Webb is certainly to be congratulated upon the plain, simple and direct manner in which he has succeeded in dealing with a subject, which, while perhaps of no great intrinsic difficulty, has too often been made difficult and repellant to the young practitioner —who, in this country at least, has not infrequently to cope with such matters without other mental equipment than a limited public school education—by a useless parade of mathematical learning. Not that we have the slightest sympathy with those who are wont to ridicule and disparage all mathematical treatment of electrical subjects, but that we do appreciate the requirements of the imperfectly taught or untaught student, who has, nevertheless, the intelligence necessary to do good work within the range of ordinary attainments, but who needs a guide to point out his way in language which he can understand.

With the utmost brevity consistent with clearness, the author first lays down the general principles of testing; then proceeds to describe, one by one, the construction and use of the several instruments and appliances, and finally explains the methods of applying the apparatus to the determination of results in the problems which arise in every-day practice. The illustrations are largely reproductions of photographs of actual instruments in use at the present day, and comprise also the necessary diagrams exhibiting the organization of the testing outfit as a whole. Some of the criticisms of the author respecting the minor details of construction in modern apparatus seem to be well founded. For instance, every one who has had experience with the detestable little commutator, which is often supplied with portable testing batteries, will heartily endorse the author's anathematization of it.

The directions for the setting up, and more particularly for the care of a testing outfit are judicious and timely, and the same may be said of the observations in respect to the importance of properly recording of the results. "In making reports or entering up records of tests," says Mr. Webb, "there can be no greater error on the part of the observer than to imagine, because certain data are well known to him, that there is no necessity to write them down. . . . . The object of keeping records and making reports is to furnish other persons with full information upon the subject," a most obvious truth, but one which is not infrequently wholly lost sight of, as those of us who have had occasion to consult such records are but too well aware.

The mechanical execution of the book is not quite up to the standard which ought to prevail in such matters. The process illustrations might at least have been as well printed in a book as they were in the columns of the weekly journal in which they first appeared, which can scarcely be said to be the case, while the binding is of that peculiarly exasperating kind which cannot be made to stay open unless a ten-pound weight is placed on it; a most annoying defect in a book required for constant reference at times when both hands are fully employed otherwise.

The intrinsic merits of Mr. Webb's book can hardly fail to ensure for it a large and permanent demand among the electrical fraternity.

Society and Club Notes.

THE ELECTRIC CLUB.

THE lecture on "The Government Telegraphs of Europe" delivered at the Electric Club last week was a very great success. Mr. Rosewater's lecture, which is given in full in this issue, was followed by a most animated discussion in which Messrs. Erastus Wiman, Insull, Foote, Bryan and Leslie participated. Mr. Rosewater's brilliant rejoinders elicited frequent applause from an audience that was evidently opposed in the main to the views he set forth. Among interested listeners were President Chandler, of the Postal Telegraph Co,; George G. Ward, of the Commercial Cable Co; George Francis Train; Gen; O. E. Madden; A. S. Brown, and W. J. Dealy, of the Western Union Co. After the lecture, Mr. Rosewater held an informal reception of Old Timers, all of whom as president of their organization he invited to the next annual meeting in Omaha.

The next meeting of the club bids fair to be a most brilliant occasion. It will be held on New Year's Eve. Mr. Joseph Howard, the famous journalist and a member of the club, will deliver a lecture on his reminiscences of journalism. Only they who have had the pleasure of hearing "Howard" speak and lecture, can form any idea of the wonderful interest that he imparts to this subject; and it is safe to predict an overflowing audience for him. The second part of the entertainment will consist of a high-class musical programme under the direction of Dr. Wangemann, whose skill and taste are so well known. Promise has already been secured of some of the best musical talent in the city.

NEW YORK PRESS CLUB.

THE annual election of the Press Club was held last week, when the regular ticket was triumphantly elected by about two to one. The second name on the ticket was that of Mr. C. W. Price, editor of *The Electrical Review*, who was nominated as vice-president. The compliment thus paid to the electrical press is a high one, and it is general cause for congratulation that the honor has been so well bestowed. Mr. Price has probably as large an acquaintance in journalism as he has in the electrical field, and that his qualities are equally appreciated in both spheres of activity is seen in the fact that he is also at the present time one of the vice-presidents of the Electric Club. Mr. Price enters upon his new duties at an interesting period, as it is the intention of the Press Club to push forward vigorously in the increase of membership and in the building of a fine club house, in the vicinity of Printing House Square. It is understood that Mr. Price will continue his active and successful work as secretary of the International League of Press Clubs. The general idea of a clubman is that of a being to whom selfish indulgence in *dolce far niente* is the chief end of existence. Mr. Price may be pointed to as an exemplar of the other kind of clubman, who believes that the club may be made to play a great part in promoting intercourse and friendship, and who is willing to sacrifice his time and money freely in making the club the centre of all that is brightest and best.

NEW ENGLAND ELECTRIC CLUB.

A STRONG effort is being made in and around Boston to establish a club under the above title now that the Boston Electric Club has become defunct, and with that end in view a paper is being circulated for signature.

It is the design of the promoters that the club shall include in its membership, representatives of every branch of the art, and that a merely nominal admission fee shall be charged that all may avail themselves of the privileges which such an organization will surely give.

Recognizing the need of such a club the signatories agree to become members of the New England Electric Club, also to pay a charter admission fee of five dollars, and dues not exceeding ten dollars per annum.

Already a large number have signified their desire to cooperate in this movement. A meeting of signers will be called at an early date for completing the organization. At this writing nearly 100 representative men throughout the electrical field in New England have given their names as prospective members, and every indication warrants the belief that it is a matter of only a short time when the incorporation of the club will take place.

THE "ELECTRICAL WORKERS OF AMERICA."

A SPECIAL dispatch from St. Louis of Nov. 28, says: "The convention of electrical linemen, which has been assembled at Lightstone Hall during the last week, has completed its work by forming a national organization of electrical workers of America. This organization will immediately apply for a charter and will send a delegate to the convention of the American Federation of Labor at Birmingham, Ala., next month. The officers of the new organization. which will be known as the National Brotherhood of Electrical Workers of America, are: Henry Miller of St. Louis, grand president; E. Hartung of Indianapolis, first grand vice-president; J. T. Kelly of St. Louis, grand secretary and treasurer. The next convention will be held at Chicago on the second Saturday of November, 1892.

Letters to the Editor.

THE BERLINER AND BELL PATENTS.

IN his article on the Berliner and Bell patents, published in THE ELECTRICAL ENGINEER of December 2, Prof. Houston appears to be in error in certain of his assumptions, a circumstance which somewhat impairs the force of his argument. As you pointed out in your editorial article of November 25, Hughes' microphone was not made public until several months after Berliner's application had been filed, nor in fact had Hughes even made the discovery at that date, so that Berliner's apparatus cannot properly be said to be merely "an application of Hughes' microphone to the telephone transmitter." Nor has the extended public use which has intervened between the date of the filing of Berliner's application and the issue of his patent necessarily any legal bearing upon its validity. A notorious illustration of this proposition might be instanced in the case of *Colgate* vs. *The Western Union Telegraph Co.* decided by Justice Blatchford in 1878. This suit was brought on a patent of one Simpson for insulating electric wires with gutta-percha. Simpson's application was filed in 1849, and even then the invention had been in public use by the telegraph companies more than a year; it was pending in the patent office eighteen years, not having been issued until 1867; during which period the invention had been in extensive public use all over the world; but the court nevertheless awarded a decree to the complainant for an injunction and accounting. It may be that the Berliner patent will fail to be sustained, but it appears to me it will hardly be overthrown upon the grounds adduced by Prof. Houston.

FRANKLIN L. POPE.

December, 4, 1891.

Reports of Companies.

SUCCESS OF THE WESTINGHOUSE REORGANIZATION.

It is authentically stated that the organization of the Westinghouse Electric and Manufacturing Company has been practically completed by the covering into its treasury of $1,000,000 in cash by Messrs. August Belmont & Co., Lee, Higginson & Co., and Brayton Ives, in payment for a similar amount of preferred stock, the sale of which they had guaranteed, and by the issue of $2,000,000 of preferred stock in cancellation of a like amount of debt.

The reorganization committee will complete its work by authorizing the Mercantile Trust Company to notify the holders of its receipts given to stockholders of the Westinghouse Company, the United States Electric Lighting Company, and the Consolidated Electric Light Company, that it will issue regular certificates in exchange for such trust receipts.

A year ago the Westinghouse Company was so seriously embarrassed that few believed that there could be found a favorable solution of the difficulties. The company was hampered by heavy rental expenses, due to the control of the United States and Consolidated Electric Light Company, and its money was tied up by the deferred accounts receivable and in heavy stocks of material, so that the continuance of regular business was difficult. During the year the company has not only continued its business, but has paid interest on its debt, cash for its supplies, and, out of collections and earnings, has reduced the liabilities of itself and leased companies over $750,000.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED DECEMBER 1, 1891.

Batteries:—

Open-Circuit Battery, J. F. Wollensak and W. E. Gill, re-issue 11,207. Filed Oct. 13, 1890.
Claim 1 follows:
In open circuit batteries, the combination of a cup having holes through its sides, a carbon stick having a hole in a position and direction to be brought into a line with the holes in the cup, and a pin passing through the holes in the cup and stick.

Conductors, Conduits and Insulators:—

Splice for Electric Conductors, W. J. Hield, 464,022. Filed May 15, 1891.
Metal splice adapted for use on trolley wires.

Electric-Wire Support, R. Ellison, 464,298. Filed May 18, 1891.
An iron pole for electric wires.

Insulating Composition, S. W. Kimble, 464,367. Filed Feb. 24, 1891.
Claim:
The composition consisting essentially of pulverized mica, silicate of soda, and a mineral substance, such as talc free from lime, combined and molded under pressure.

Insulating-Support for Electrical Apparatus, S. W. Kimble, 464,368. Filed Feb. 25, 1891.
An improved method of mounting binding posts, etc., upon their non-conducting supports.

Composition of Matter for Insulating Purposes, etc., S. W. Kimble, 464,369. Filed Feb. 26, 1891.
An insulating material consisting of pulverized mica, silicate of soda, sulphur or sulphur compound, and another mineral substance, such as finely divided asbestos, molded cold under high pressure.

Joint for Electric Conductors, H. W. Fisher, 464,475. Filed Mar. 7, 1891.
Claim 1 follows:
An electric cable consisting of two or more portions of armored conductors having their ends united by a hollow cast metal joint, forming an integral part with the adjacent sections of armor.

Distribution:—

Electric Regulator, C. W. Holtzer and G. E. Cabot, 464,136. Filed Apr. 3, 1891.
A device for operating a rheostat in an electric light or power station in such a manner as to obtain a uniform electromotive force in the current on the main line by including and excluding resistances, according to the nature of the variation of the electromotive force.

Relay, R. Varley, Jr., 464,133. Filed Feb. 10, 1891.
Claim 1 follows:
A relay provided with an armature carrying a rearwardly-yielding contact mounted to lag under the influence of inertia when the armature is attracted, whereby the circuit controlled by the relay is affected only when currents of definite duration flow through the relay coils.

Dynamos and Motors:—

Transformer and Armature-Core, C. E. Kammeyer, 464,026. Filed May 7, 1891.
Claim:
An armature core consisting of a series of plates, said plates provided with permanently flexible insulating coats of varnish or the like applied permanently to the plates, which are then built together to form such core.

Field-Magnet for Dynamos or Motors, C. E. Kammeyer, 464,027. Filed May 9, 1891.
Has for its object to provide a cheap, simple and convenient device for retaining the magnetizing coils in connection with the field-magnet and to facilitate their removal and substitution if necessary.

Electric Motor, M. H. Collon, 464,063. Filed Jan. 27, 1891.
Claim 1 follows:
An electric motor comprising a solenoid and an endless core forming an electrical conductor to convey the current to and adapted to complete the circuit through the said solenoid.

Electrical Generator, V. Hirbec, 464,156. Filed Nov. 6, 1890.
Two forms of electric generators, the one designed for the teaching of physics and the other for industrial use.

Armature for Dynamos and Electric Motors, St. J. V. Day, 464,216. Filed May 1, 1890.
Claim:
The combination, with a shaft of an armature mounted thereon and means for securing one end of the said armature to the shaft, the opposite end thereof being free to expand and contract longitudinally.

Electric Motor, H. A. Florian, 464,299. Filed Jan. 6, 1891.
Has for its object a standard electric motor which shall be durable, compact and efficient and not liable to get out of order.

Electric Motor, J. R. Robinson, 464,231. Filed Feb. 3, 1891.
Claim 1 follows:
The combination of a stand or support with a swinging electric motor suspended by a gimbal joint from said stand.

Heating:—

Electric Heating Apparatus, M. W. Dewey, 464,247. Filed March 9, 1891.
Consists of the combination of a plurality of cases, an electric heat-developing conductor within each of said cases and a frame to hold or support them.

Electric Heater, P. Wright, 464,055. Filed March 21, 1890.
Claim 1 follows:
The combination, in an electric heater, of the base and cap constructed of conducting material, an intervening inclosure constructed of non-conducting material, and an enclosed medium of high electrical resistance.

Lamps and Appurtenances:—

Treating Filaments for Incandescent Electric Lamps, J. Bradley, 464,005. Filed June 6, 1891.
Provides means whereby a carbonized filament may be freed from loose or partially detached particles of carbon.

Electric Arc Lamp, W. A. Nicholson, 464,132. Filed June 12, 1891.
Relates to improvements in that class of arc lamps using a carbon disc in place of the upper carbon pencil.

Electromagnet, O. E. Lundstedt, 464,198. Filed Feb. 2, 1891.
An electromagnet for use in connection with the controlling mechanism of an arc lamp.

Metallurgical:—

Process of and Apparatus for Manufacturing Copper Tubes, A. S. Elmore, 464,351. Filed Dec. 1890.
Method of manufacturing copper tubes by means of electro-deposition.

Measurement:—

Potential Indicator, C. E Kammeyer, 464,025. Filed May 7, 1891.
Claim 1 follows:
The combination of an electric generator with translating devices in series with each other, a circuit closer, and connections whereby either one of them may be short circuited, said circuit closer responsive to changes in the current delivered.

Method of Testing Insulated Wires, R. Varley, Jr., 464,135. Filed Feb. 10, 1891.
Claim 4 follows:
The method of testing an insulated wire which consists in surrounding the insulated covering with a fluid conductor connecting the wire and such fluid conductor with the terminals of an electric circuit carrying an alternating or reverse current and interrupting the circuit when a flash is developed at a point of defective insulation.

Miscellaneous:—

Lineman's Vise, J. McIsaac, 464,034. Filed July 6, 1891.
An improved form of vice for lineman's use.

Electric Circuit Closer, R. Varley, Jr., 464,134. Filed Feb. 10, 1891.
A high-tension circuit closer by which a very brief closure of the circuit or a prolonged closure may be made at will.

Watchman's Electric Recorder, H. Redding, 464,256. Filed Apr. 16, 1889.
An electric recorder and registering system for the use of watchmen.

Phonograph, G. H. Herrington, 464,476. Filed Sept. 11, 1886.

Electric Elevator, W. Baxter, Jr., 464,470 Filed Dec. 8, 1890.
Has for its main object to provide means of closely connecting an electric motor with a hoisting pulley and gearing without injuriously affecting the action of the magnetic field of the motor.

Magneto-Electric Ignitor for Combustible Vapor Engines, L. G. Wooley, 464,347. Filed Sept. 26, 1890.
Claim 4 follows:
In combination with a combustible vapor engine, an electric machine adapted to produce a pulsating current and a current breaker located within the combustion chamber of said engine, rotating synchronously with the armature of said electric machine and adjusted to break the circuit only at the point of highest tension of said current.

Railways and Appliances:—

Electric Brake, LaM. C. Atwood, 464,002. Filed Feb. 27, 1891.
A brake for street cars operated electrically by means of solenoids.

Electric Apparatus for Use on Railway Trains, R. A. Wilder, 464,090. Filed Jan. 9, 1891.
Has for its object the utilization of the potential energy of railway trains by means of electric apparatus.

Method of and Apparatus for the Propulsion of Trains, J. B. Mahana, 464,342. Filed Jan. 24, 1891.
Has for its object to utilize the full energy of an electric locomotive, when not needed to move the train, in storing up surplus power for use in cases of emergency.

Trolley-Wheel for Electric Railways, S. W. Kimble, 464,370. Filed May 29, 1891.
Claim 3 follows:
A trolley-wheel provided with rubber tires on the flanges between which the trolley-wire groove is formed.

Trolley Wire Hanger, S. W. Kimble, 464,371. Filed May 29, 1891.
Has for its object to produce a hermetically sealed insulated trolley hanger and analogous appliances.

Hanger for Trolley Wires, T. E. Adams, 464,411. Filed July 17, 1890.
Claim 13 follows:
In an insulator, the combination, with a metallic shell, of a shank and insulating material therein, and flanges on said shank imbedded in the insulating material, so that said insulatidg material will form more than one canopy around said shank.

Crossing for Trolley Wires, R. M. Jones, 464,129. Filed April 16, 1891.
Has for its object to provide a crossing which shall insure a perfect insulation of the wires of the respective systems.

Telegraphs and Telephones:—

Telegraph Repeater, R. L. Atkinson, 464,001. Filed Mar. 27, 1891.
Relates to improvements in telegraphic repeaters and is especially designed to remedy a fault in the operation of Brownson & Shull's repeater, described in Patent No. 66,945.

Electric Transmitting Telephone, R. Eickemeyer, 464,152. Filed May 23, 1891.
Has for its object to equalize the vibrations of the transmitting diaphragm so that the greatest vibration possibly resulting from the human voice will be incapable of breaking connections at the contact points and will be as readily distinguishable as those produced by ordinary conversation.

Vehicles:—

Electric Fire Engine, M. W. Dewey, 464,244. Filed Feb. 9, 1891.
An electric fire engine electrically propelled.

Electric Hose Carriage, M. W. Dewey, 464,245. Filed Feb. 24, 1891.
An electrically propelled hose carriage, the hose reel of which is also operated electrically.

Electrically Propelled Vehicle, M. W. Dewey, 464,246. Filed Mar. 2. 1891.
Has for its object to electrically guide a self-propelled wheeled vehicle.

Electrically Propelled Vehicle, M. W. Dewey, 464,248. Filed Mar. 23, 1891.
Relates to mechanism for electrically propelled vehicles having wheels on opposite sides adapted to turn relatively to each other in order to facilitate the turning of corners.

MR. GARDINER C. SIMS, of the Armington & Sims Engine Co., has, we note, acted as one of the expert valuers of the property acquired by the Rhode Island Perkins Horse Shoe Co., one of the largest industrial properties put on the financial market this year. His associates were Mr. William Corliss and ex-U. S. Senator Chace. The business reported on has been earning a profit of over $260,000 a year for a long time and the authorized capital of the new company is $2,750,000. Mr. Sims has served several times in such a responsible capacity, and is much sought after when questions arise as to the value of manufacturing plants and processes.

THE THOMSON-VAN DEPOELE NEW "ARC" COAL UNDERCUTTING MACHINE.

THE undercutting of coal by machinery is an important problem for the mining fraternity. The undercut may be made by hand, but this method not only adds largely to the expense of mining coal, but also makes a large quantity of fine coal or slack which is comparatively a waste product except in certain cases. To avoid this difficulty and to furnish a machine which shall be easy to manipulate, the Thomson-Van Depoele Electric Mining Co., of Boston, have designed their new "arc" machine, which is illustrated in the accompanying engraving.

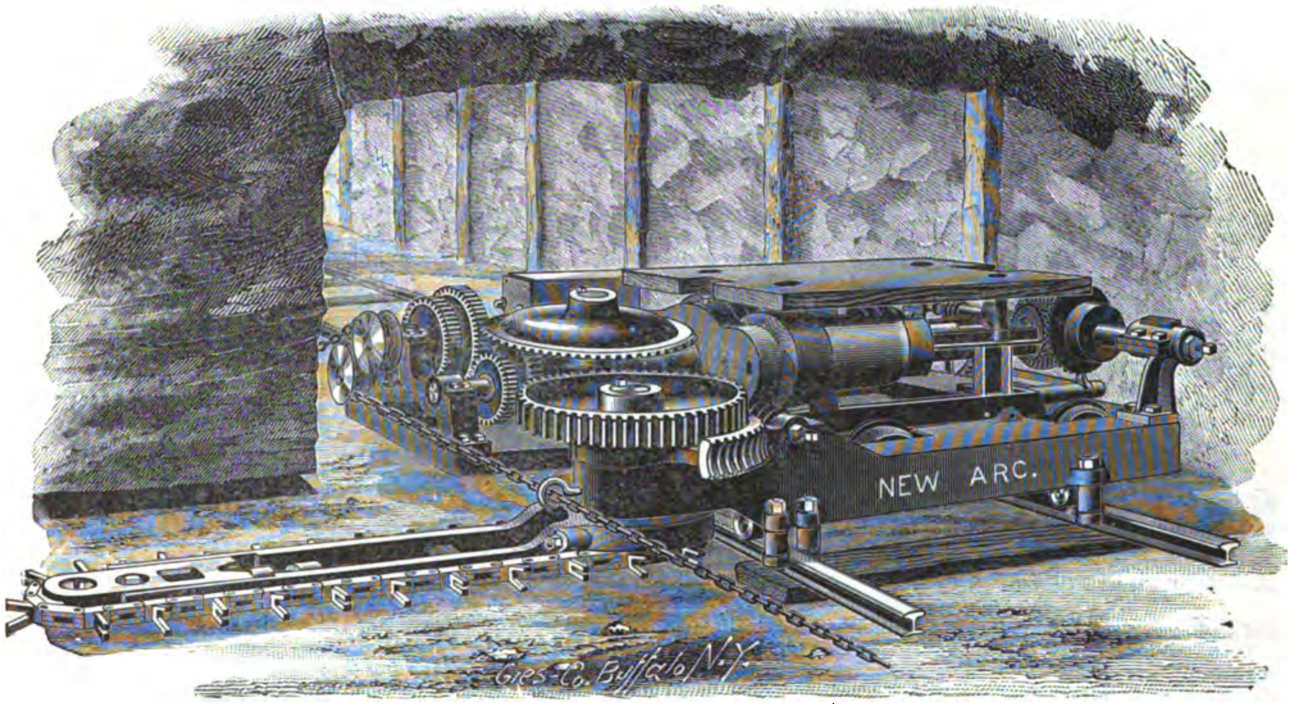
As will be seen, it consists of a heavy iron base cast in one piece which serves as a foundation for all the parts, carrying two pairs of axles, one at right angles with the other. The gauge of one pair is fixed to suit the regular track gauge of the mine wherein the cutter is to work, and these axles carry small flanged wheels upon which the cutter is easily moved about the mine and in and out of the rooms. The second pair of axles carry small wheels for supporting the cutter when in actual operation and carrying it along the face of the wall being cut. They are not flanged, but are kept upon the track by two pairs of single and two pairs of double guides. The support of the machine is easily changed from one pair of axles to the other by means of a cam worked by screws, the larger flanged wheels being raised out of the way when the cutter is in actual operation, as shown in the illustration.

The motive power is furnished by a 15 h. p. motor, which in the latest machine is somewhat changed from that shown, the motor being perfectly water-tight and thoroughly protected from all danger of mechanical injury. The armature shaft carries a beveled pinion at each end. That nearest the commutator is made to engage, by means of a controlling arm, either one of the two beveled gears shown in the illustration, thereby giving the shaft on the right a right-handed or left-handed rotation. By means of the chain of gears and an ingenious mechanical device, this shaft operates the feed chain at practically any desired speed. The feed chain is made fast to a post ahead of the machine and in this way the cutter is drawn forward at a speed under control of the operator, and which can be varied with the hardness of the coal. The same gearing by means of another controlling lever is made to move the arm from a position alongside the machine at the beginning of the cut to the position shown in the illustration, where it is held rigidly during the remainder of the cut. The second pinion on the armature shaft operates the endless chain carrying the cutting knives about the arm.

The controlling devices are such that the cutter may be held stationary while the knives are in operation, an important point in cutting through particularly hard formations. The length of the arm carrying the endless chain is made to suit the requirements of the mine in which it is to operate, the undercut usually being made of a depth equal to the thickness of the vein.

The length of the arm is adjustable within certain limits in order to take up the stretching of the chain due to wear. The chain and knives are drop forged and of a strength to withstand the hardest usage. The knives are easily detachable from the chain so that a new set of sharp knives may be substituted for the old set in a very short time. The track along the face of the work consists simply of two rails with an iron cross-tie, and may be laid and removed in a very short time and with a small amount of labor. By the use of this track and this type of machine, the necessity for removing a heavy piece of apparatus by hand, oftentimes in a very low room, is avoided—a very important point and one which will be appreciated by those who have had experience in these matters. For its operation the cutter requires two men, one of whom is at the machine itself controlling the rheostat and operating devices; the other keeps the track laid ahead and sets posts for anchoring the feed chain. All trouble with the slack clogging up the cut is obviated as the knives themselves bring nearly all the slack outside the cut, leaving a clean space.

The machine is thus seen to possess very important advantages in all kinds of working and for large room working, or along wall system these advantages become all the more prominent. It is operated on a 220 volt circuit, making it entirely harmless electrically.



THOMSON-VAN DEPOELE NEW "ARC" COAL-CUTTER.

THE PITTSBURGH WESTINGHOUSE WORKS.

PART of the plant of the Westinghouse Electric Company will likely be moved. The officials are considering the change in location of the street railway motor department, which is about one-half of the plant, to the recent site of the Air Brake Works, on Robinson street, Allegheny. Superintendent Schmid, says:

"We are running night and day and taxed to our utmost capacity in turning out orders for gearless railway motors, and cannot begin to fill the orders which are coming from all parts of the country. The demand for more room is imperative, and we could utilize as much more as we now have. Mr. Westinghouse and the other officials of the company are considering the advisability of moving this department to Allegheny, but have arrived at no definite conclusion in the matter."

THE DONALDSON-McRAE ELECTRIC CO.

PROF. OWENS, of the University of Nebraska, has just given the Donaldson-McRae Electric Company, of Baltimore, an order for 50 of their new design of storage batteries, and an order for a dynamo and motor for the laboratory of the University. The Donaldson-McRae Electric Company make a specialty of winding motors for storage and primary battery currents and are doing a brisk business. They are also introducing a storage battery of their own which is giving great satisfaction in phonograph and other work of a similar nature, where absolute reliability and a great number of ampere hours are desired.

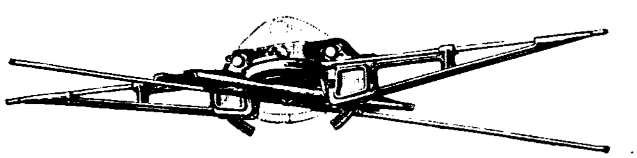
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The cost of advertising is a small percentage of the larger profit.

NEW FORM OF BAGNALL LIVE TROLLEY CROSSING.

THE Emerson Electric Co., of St. Louis, have lately introduced the improved form of Bagnall live trolley crossing shown in the accompanying illustration. The new form is so constructed as to operate in either direction, and is therefore applicable to either double or single track service. This is effected by using two bridge levers so jointed together as to meet at the centre of the crossing gap when actuated by a trolley wheel. In the normal position the two levers are separated from each other by the action of gravity on their counterweighted parts.



NEW BAGNALL LIVE TROLLEY CROSSING.

By means of a trough-shaped inclined plane attached to the under trolley wire the height of the cross-over has been reduced. The size has also been reduced about one-half, but all the parts are constructed more substantially than ever before. An insulated hood protects the working parts from sleet and also prevents a cross-connection between the two trolley wires.

This new form of trolley crossing is being placed upon the market at a lower price than the old form, and has already met with a very favorable reception.

THE TRIUMPH COMPOUND ENGINE CO.

THE Triumph Compound Engine Co., of Cincinnati, O., recently received the following letter:

ROCHESTER, N. Y., Nov. 21st. 1891.

TRIUMPH COMPOUND ENGINE CO.,
Cincinnati, O.

GENTLEMEN: The engine that you furnished us a few months ago has been doing good service and we are well pleased with the performance of the same. We have been trying same under most adverse circumstances, unsuitable boilers and connections, being compelled to use temporary boilers while putting in new. The test made October 28th by Mr. Caudle and our Mr. Lauer was highly satisfactory as well as surprising, the fact as shown by cards Nos. 6 and 8 that the engine was carrying a load of 115 and 117 h. p., taking steam through a 2 inch pipe instead of a 4 inch, carrying the steam over 100 feet to the engine.

You will remember that you would not guarantee to me a horse-power over 90, although you thought it might show 100. We will be pleased to show this engine and its performance to any one who is desirous of seeing a novel and unique machine get around at the rate of 350 revolutions per minute.

Yours truly,
A. DOLBEER,
Superintendent Motive Power,
Buffalo, Rochester, and Pittsburgh Railway Co.

THE CLARK ELECTRIC SEARCH LIGHT.

A special silver medal was awarded the Clark Electric Company, 192 Broadway, New York, by the American Institute, at the close of the Sixtieth Annual Exhibition, November 28th, 1891, for the Clark electric search light. The new and novel features of this light created great interest and it was one of the attractive features of the exhibition.

To see an arc lamp turned in every possible position and burning perfectly at every possible angle was something new; it elicited many inquiries.

The light was thrown in every nook and corner of the building and upon the floor directly under the lamp and then to the ceiling, searching out all the imperfections of the old Institute; and sometimes in the eyes of the visitors

The Clark Company are constantly bringing out new and valuable improvements in arc lighting, of which they make a specialty. They have established a high reputation for the apparatus of various kinds which they manufacture, the merits of which are proven by the rapidly increasing demand from their former customers as well as from many new sources.

DAY'S KERITE.

THE many friends of Kerite and of Mr. W. H. Eckert, will be glad to learn that the gentleman named has succeeded to the general management of Day's Kerite, vice G. B. Prescott, Jr., resigned. Mr. Eckert has had a long and valuable experience in the electrical field, and particularly in those lines where Kerite has made its greatest successes. The following announcement has been made by the firm.

NEW YORK, December 1, 1891.

The undersigned desires to announce to the electrical industries that he has assumed the management of the long established and celebrated insulated wire and cable business of A. G. Day (S. A. Day, successor), and that he is prepared to supply their wants in the line of high grade insulation.

It is unnecessary to refer to the character of the goods, as it is a well-known fact that the Kerite insulation is the best, having been used for the greatest number of years and sold to the largest extent of any insulation in the market.

Trusting that the users of Kerite will continue to approve its qualities, and all others who desire a first-class insulation, that has been successfully employed for aerial, subterranean and submarine purposes for more than 25 years, will test its merits, I am

Very truly yours,
W. H. ECKERT,
General Agent.

DALLETT & CO. DYNAMOS AND MOTORS.

MR. NEWTON L. SCHLOSS, 126 Liberty street, reports the following recent orders: 1 one h. p. motor, Charles Vogt & Co., printers, 132 Church street; 1 five h. p. motor, Montague & Fuller, bookbinders' machinery, 28 Reade street; 1 five h. p. motor, Smith & Seward, coin makers, 92 Fulton street; 1 ten h. p. motor, Charles Hirsch, electrotyper, 113 Nassau street; 1 fifteen h. p. motor for elevator work, R. C. Williams, grocer, Thomas and Hudson streets; 1 90 kilowatt generator, 1 100 h. p. motor, 1 125 h. p. Triumph valveless compound engine, wiring for 1,000 lights, and two Hunter clutches, for N. Y. Biscuit Company, Tenth avenue and Fifteenth street, city. The plant for the New York Biscuit Co. will be coupled direct.

These are the Billberg motors and dynamos made by Thos. H. Dallett & Co., of Philadelphia, of which firm Mr. Schloss is New York agent. The engine is the valveless Triumph compound engine which is represented solely in the East by Mr. Schloss.

THE WESTON STANDARD VOLTMETER IN GERMANY.

W. LE CONTE STEVENS writing to Mr. Edward Weston, vice-president of the Weston Electrical Instrument Company, Newark, N. J., says that the Weston Standard Voltmeter is held in very high esteem in Germany. At a lecture recently attended by him at the Polytechnic School in Zurich, the lecturer, who was a member of the Testing Commission at the recent Frankfort Electrical Exhibition, said he had subjected the Weston voltmeter to various tests and found it in the highest degree satisfactory—the best thing from America that was exhibited at Frankfort. As an illustration of the excellence of the magnet employed, he stated that an instrument having fallen accidentally upon the floor, its subsequent indications were not affected more than ⅛ of 1 per cent. by the mishap. The Weston Electrical Instrument Company are very busy.

THE GERMANIA ELECTRIC CO.

THE following letter speaks well both for the Germania shade-holder as a desirable article of manufacture and THE ELECTRICAL ENGINEER as an advertising medium:

HELSINGFORS, Nov. 7, 1891.

GERMANIA ELECTRIC CO,
505 Exchange Building,
Boston, Mass.

DEAR SIRS: Enclosed please find draft on New York for $7, in exchange for which please send us one gross of your Germania shade-holders as advertised in THE ELECTRICAL ENGINEER.

The best way to send them is via Hull, and we should like to receive same as early as possible.

We are, dear sirs,
Yours faithfully,
HELSINGFORS ELEKTRISKA BELYSNINGS AKTIEBOLAG.

AN ELECTRIC EXCHANGE FORMED AT ST. LOUIS.

A NUMBER of electrical supply companies and contractors of St. Louis have got together and formed an association and named it the St. Louis Electric Exchange. The officers elected are: R. C. Wolfram, president; Ed. E. Cook, vice-president; R. V. Scudder, secretary, and R. Dodsworth, treasurer. The regulations provide that no member of the association shall buy from, or sell to, any company or contractor who does not come up to the regulations of the association. They will begin operations at once, and a lively fight is expected from those who are opposed to being forced to comply with these regulations.

PASS & SEYMOUR INSULATORS.

THE accompanying illustrations, Figs. 1 and 2, show two novel forms of insulators recently introduced by Pass & Seymour, of Syracuse, N. Y. Fig. 1 is a circuit-break insulator, in which the distance between the wires is very great. This may also be used equally well as a tree insulator. It is made in two sizes, and is sufficiently strong to stand the breaking strain of any wire that may be fastened to it.

The cleat, shown in Fig. 2, is intended to take the place of those of wood, now in general use. It is so made that the wire may be held in position loosely until properly adjusted, when, by tightening the screws, it is bent in the rounded jaws of the cleat and held very firmly. This insulator holds any size wire from the smallest used to No. 6.

Both of these articles are made of Syracuse china, fully glazed. The cleat, however, is furnished in the unglazed state for concealed work.

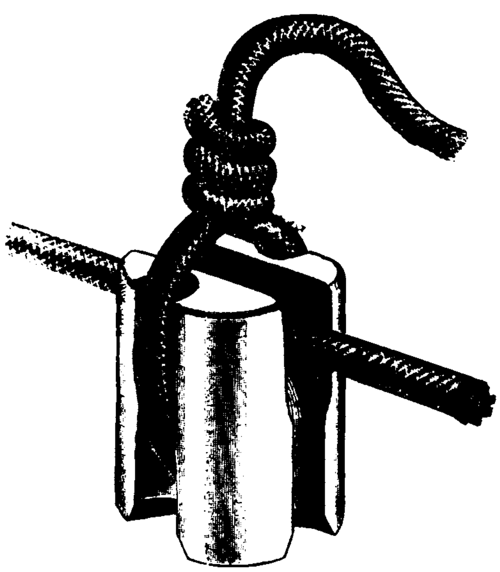


FIG. 1.—PASS & SEYMOUR'S CIRCUIT BREAK INSULATOR.

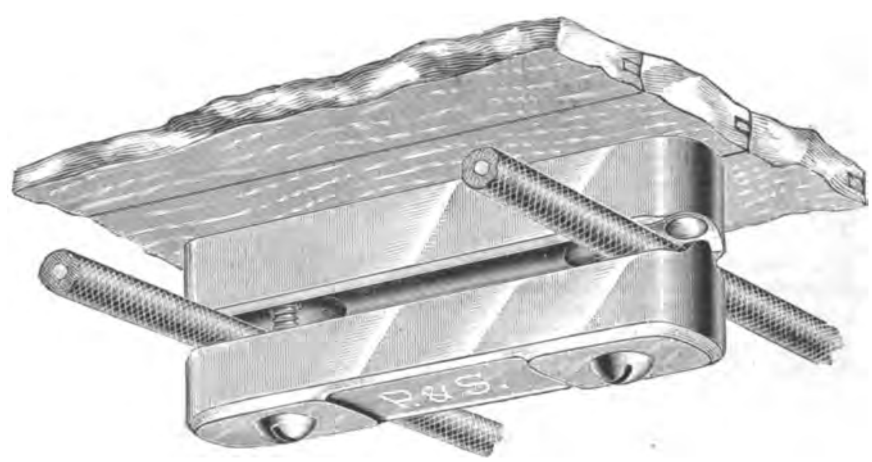


FIG. 2.—PASS & SEYMOUR'S CHINA CLEAT.

THE D. M. STEWARD MANUFACTURING CO.

THE above concern is in itself one of the most remarkable instances of the wonderful development of the new South. Its principal now has his factory established literally on the very spot where he once bivouacked as a Union soldier, and he transferred his business to Chattanooga from Ohio because of the greater advantages to be found in Tennessee. Lava insulators, one of the many special products of this progressive concern, have now become a "household word" in the electrical industry, a fact pretty clearly brought out by orders running up to 200,000 pieces in a single week.

CENTRAL ELECTRIC CO.

The Central Electric Company has just received a large importation of all-steel pliers of standard sizes. These goods are guaranteed to be all steel and superior to any on the market, and are being offered at very attractive prices. The company has also received, direct from Germany, an importation of sal ammoniac, which is guaranteed to be the pure article, and on which they make low prices on large quantity orders.

FIRES IN CHICAGO CENTRAL STATIONS.

Our Chicago correspondent writes us as follows, with regard to the two recent fires in that city:

CHICAGO ELECTRIC LIGHT AND POWER CO: I saw Mr. Wilmerding, secretary and treasurer. He says that the loss is not nearly as great as at first expected. It is chiefly in the building, fixtures, and dynamos. The engines, boilers and most of the shafting are in good shape and will be able to be used very shortly. The dynamos are chiefly damaged by water, and a large portion of them can be fixed up. They are making arrangements for temporary power in various points and have already made arrangements to take care of about a quarter of their load, and in a week expect to have all their lamps running. They will immediately commence reconstructing the plant. The loss is almost fully covered by insurance. The amount of loss has not yet been accurately determined.

CENTRAL ELECTRIC LIGHT CO: This plant is an entire wreck. Perhaps the engine may be saved, but that is not yet certain. They expect to be able to take care of all their lights from the 3d Avenue plant.

CENTRAL ELECTRIC COMPANY, CHICAGO.

THE Central Electric Company have again added to their quarters, being obliged to secure increased storage capacity for their stock. The large line this company handles, which includes appliances for all classes of electrical work, necessitates carrying a very large stock, and the business has increased very handsomely during "dull times." This company, who are always in the front rank of progress, have recently put in a large stock of electric light carbons that will enable them to furnish carbons to consumers in Chicago at factory prices. The sales of Okonite wire have been larger than ever before, evidencing advancement in the use of high-grade materials throughout the electrical fraternity. The Swan incandescent lamp, for which this company are general Western agents, has obtained a popularity in their hands that is also deserving of mention. The branch houses of this company, viz., Southern Electrical Supply Company of St. Louis; Gate City Electric Company of Kansas City; Western Electric Supply Company of Omaha, and the Electric Power Transmission Company of Denver, are doing a thriving business and in this connection, the Central Electric Company can be said to lead the van in the West. The company carry the Swan lamps in all voltages and candle powers, and will fill the largest orders promptly. The lamp is said to show a very small watt consumption to the candle-power.

MEETING OF SUPPLY MANUFACTURERS.

AT the call of a number of gentlemen interested, a meeting of electrical supply manufacturers was held at the Hotel Metropole in this city last week, at which a number of questions of importance to the trade were discussed. Principal among them were the prices to be charged for switches and sockets to various classes of concerns. As a result, it was decided to allow a sliding scale of discounts to concerns which were classified as follows: A, Large firms that do no construction work; B, Supply houses that do no construction; C, Construction companies that do not deal in supplies.

The sessions were held with closed doors and the meeting adjourned subject to the call of the chair.

GERMANIA ELECTRIC CO.

THE Germania Electric Co. has recently installed electric lighting plants in the following places: Hermann Bonitz, Lodi, N. J., one 50-light machine; De La Vergne Refrigerating Machine Co., New York, one 500-light machine; J. S. Mundy, Newark, N. J., one 400-light machine; the Newichawanick Co., South Berwick, Me., one 300-light machine; the Pabst Brewing Co., South Boston, complete steam and electric plant for 100 lights. This is an exceedingly good showing for a company who have but recently commenced to give the dynamo business any special attention.

THE NEW ENGLAND SWITCH.

IN the accompanying illustration is shown the "New England Switch," the general Western agency for which has been secured by the Electric Appliance Co., of Chicago. It is constructed on correct mechanical and electrical principles, the best of material being used throughout, and is strong, neat in appearance, and at the same time remarkably simple in construction and very durable and reliable. The contact pieces consist of copper brushes, giving high conductivity, backed up by German silver springs, and are forced down and held firmly between the contact lugs by

THE "NEW ENGLAND" SWITCH.

a "cam," making an excellent contact, which it is impossible to break without turning the handle.

These switches, it is stated, are in great favor among electrical engineers throughout the country and giving the best of satisfaction. They are made in sizes of from ten to fifty amperes on porcelain bases, and 75 and 100 amperes on slate bases.

INTERIOR CONDUIT AND INSULATION CO.

THIS company, of 42 and 44 Broad street, has just issued a new batch of circulars relative to its brass-armored tube, elbows, tees, &c.; standard elbows and tees; twisted wire clips for conduit tubes, and attaching plug and receptacles. The clip is made of iron wire in two sizes. The plug is of hard rubber, and the receptacles are mounted on porcelain base or in the regular branch box. With regard to the elbows, we note that the company is prepared to supply them in future with the couplings attached. The new price list for the brass-armored tube shows an extremely low cost for this useful article.

ELECTRIC APPLIANCE CO.

THE ELECTRIC APPLIANCE COMPANY report having closed arrangements for the exclusive Western agency for the New England switch, which is described elsewhere in this issue, and also for the entire line of specialties manufactured by the Consolidated Electric Manufacturing Company, of Boston, some of which are the C. E. M. jack-knife switches, C. E. M. sockets, Wade dynamo register, O. R. W. oil filter, S. & W. speed indicator, "telescope" switchboard plug, Davis arc cut-out and Corthell lamp adjuster, which, with the addition of Paranite wires, "swinging ball" lightning arrester and Walker ammeter, mention of which has already been made, gives them a most desirable line of specialties and one that will undoubtedly enable them to command a large trade from the very start.

A THRIVING YOUNGSTER.

JUST two years ago George Cutter brought out a street hood which embodied a number of new features. Last week an order for 250 brought the number in use up to ten thousand, and yet the stern owl in the cut says "Still there's more to follow."

IN the description of the new Thomson-Houston freight locomotive described in our last issue we omitted to mention that the designing of this locomotive was done by Mr. C. H. Veeder, under the supervision of Mr. J. P. B. Fiske, who has charge also at the Lynn factory of all the motor work now being done by the company except the railway work and long-distance transmission.

THE DETROIT ELECTRICAL WORKS have closed a contract with the Kokomo City Electric Railway Co., of Kokomo, Ind., for an 80,000 watt generator and five 30 h. p. motor equipments, to be delivered on or before Dec. 15.

PHILADELPHIA NOTES.

THE LA ROCHE ELECTRIC WORKS have received an order from James W. Queen & Co., of this city, to build a direct-current dynamo, an alternating dynamo and a motor to run them, all of which are to be specially made and of the best of material that the market affords, and will be highly finished with all the latest improvements. Inasmuch as Queen & Co. demand the best machinery that can be produced for the use of calibrating instruments in their new laboratory at 1010 Chestnut street, the La Roche Company feel highly complimented for receiving this order.

THE HEISLER ELECTRIC CO. is installing plants for their long-distance incandescent lighting in the towns of Matteawan, N. Y., Homer and Chelsea, Mich., and an additional plant at Union City.

THE CRESCENT INSULATED WIRE CO., of Trenton, N. J., have found a ready market for their rubber-covered wire as fast as they have been able to turn it out. They will be compelled to increase their facilities for manufacturing shortly.

THE IMPERIAL PORCELAIN WORKS, of Trenton, N. J., have created such an enviable reputation for making fine porcelain for electrical purposes that they are scarcely able to fill their orders. Mr. F. A. Duggan, the proprietor, with long years of experience fully appreciates what the electric trade demands. This with his personal supervision and promptness in filling orders has built up for him a most successful business.

MR. T. L. TOWNSEND, of the Partrick & Carter Co., has just returned from a three month business trip through the West and South. Although Mr. Townsend has been over the same territory many times, representing the same company, which is one of the oldest in the country, he says there never before was such a demand for their goods.

WESTERN NOTES.

THE ILLINOIS ELECTRIC MATERIAL CO. report business as flourishing and the demand for "Canvas Jacket" line wire and Bishop india-rubber covering wires and cables as being exceedingly good.

THE ELECTRIC APPLIANCE CO., of Madison street, Chicago, are beginning to take some nice orders for Paranite rubber insulated wires and cables and also for other general electrical supplies. Mr. W. W. Low, of the company, has just returned from the East, where he has been making arrangements to take the agency for various good specialties.

MR. C. E. OLDACRE has been in Chicago during the past week attending to important business for his company.

MR. WM. HOOD, 239 La Salle street, Chicago, says that he is receiving some very nice repeat orders for Jewel incandescent lamps. In places where he has taken orders for from ten to fifty he is now receiving orders for from 200 to 500 and upwards, which is a very convincing proof of the general satisfaction that the lamps are giving. The Mosher arc lamp, for which he is general agent, is also meeting with good success, the Mosher Co. having recently started out a new style of lamp containing important improvements, and the sales of which are expected to be very large.

THE GREAT WESTERN ELECTRIC SUPPLY CO. are doing their share of business, filling orders for all kinds of general electric lighting, power and railway supplies from all parts of the country.

THE ELECTRIC MERCHANDISE CO. are meeting with the most excellent success in the introduction of their Burton electric heaters. Parties who have used the heaters are continually sending in orders for more sets and expressing in gratifying language their appreciation of the work their heaters are doing.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

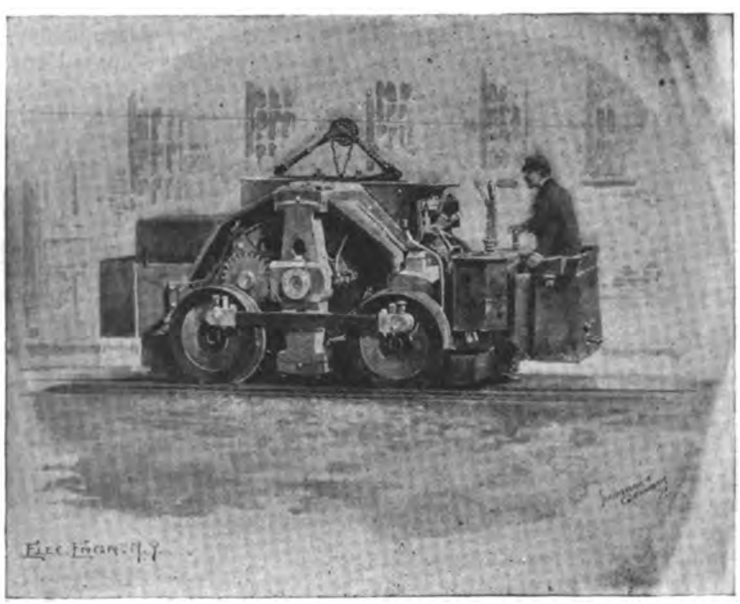
THE

Electrical Engineer.

VOL. XII. DECEMBER 16, 1891. No. 189.

THE EDISON ELECTRIC LOCOMOTIVE FOR MINE WORK.

DURING the past year a number of articles have appeared in THE ELECTRICAL ENGINEER, descriptive and illustrative of electrical mining apparatus; and it must have been evident to all that the work was entering upon a further stage of magnitude and importance. Some idea of the scale upon which operations are now conducted may be formed from the sketch here given of the new mining locomotive recently built by the Edison General Electric Co. for the Loyalhanna Coal Co., of Philadelphia. It is, we believe, by far the largest electric mining locomotive ever built. The contract with the Loyalhanna Co. called for a locomotive able to deliver 360 tons of coal every hour at the bottom of the shaft. To do this necessitates hauling a train of 30 coal cars over an average distance of 4,000 feet every 15 minutes. Each car weighs about one ton and contains three tons of coal; the total weight of each train is, therefore, about 120 tons. As there are numerous sharp curves and grades varying in steepness up to four and five per cent., some idea can be formed of the power necessary to do the required work. The usual speed with a train of 120 tons will be about 7½ miles per hour, but during the test made two weeks ago a speed of 12 miles per hour was attained, and the heavy trains were handled with ease and facility, the capacity of the locomotive being found to be far in excess of the requirements. The motor is of the four-pole type, and built in the most substantial manner. The magnets and the armature are protected from injury by iron casings. The power is transmitted from the armature to one axle by heavy gears, and the wheels on this axle are connected to the others by connecting rods, as on a steam locomotive. The full tractive effect of both pairs of wheels is thus obtained with the least amount of gearing. The track gauge is three feet eight inches, and the distance from centre to centre of the axles is the same. The speed of the locomotive is governed by a special controlling switch and the seat of the driver is so arranged that he can easily look in either direction, according as he is running one way or the other.



THE NEW EDISON MINING LOCOMOTIVE.

Sand-boxes are provided for sanding the rails in case of the wheels slipping. These are controlled by two handles placed within easy reach of the driver. The track is of T rail, thoroughly "bonded." About one mile of track has already been laid, and the length in the main entry alone is expected to reach nearly two miles. Several branches turn off from the main line into workings on either side. The trolley-wire, which extends along the track overhead, and from which the current is taken, is carefully supported on insulators especially designed for damp locations, and is also protected by an inverted wooden trough supported above it upon cross timbers. A heavily insulated copper feeder wire runs the entire length of the track, and is connected to the trolley-wire every hundred feet or so by branch wires. The feed-wires and trolley-wires running off on the branch lines are connected to the main wires through cut-out boxes, or switches, by means of which the electric current can be shut off whenever desired.

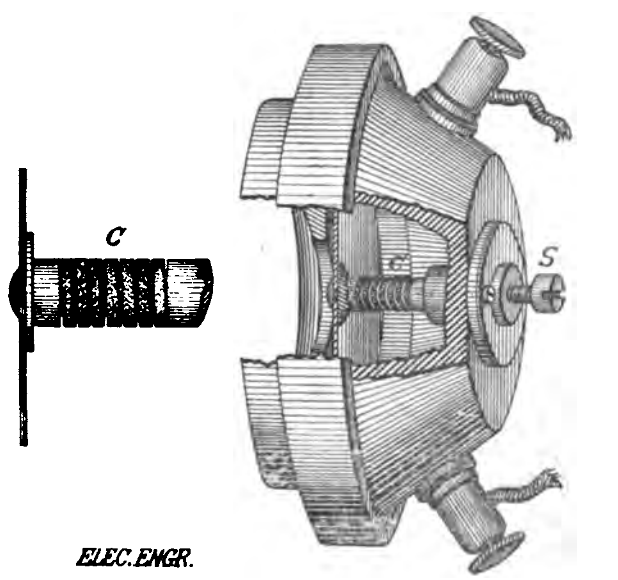
The generating dynamos which furnish the electric current are located in the same room as the hoisting-engines. They are two in number, compound-wound, of the most improved type manufactured by the Edison Company, and are driven by a high-speed steam engine of 150 horse-power. The wires are carried from the dynamos to a switchboard on the wall, where are placed the controlling devices, switches and other apparatus, all within easy sight and convenient of access for the engineer in charge. From the switchboard the heavy conducting wires are carried down the air-shaft into the mine, a vertical distance of 200 feet. Great care has been paid to all essentials, and in every respect this may be considered a model installation. The results already obtained will lead to increased application of such locomotives in the near future.

A TELEPHONE TRANSMITTER WITHOUT ELECTRODES.

BY

Chas Cuttriss

WHILE it would appear that the field of telephone transmitters had been pretty thoroughly gleaned, still among the stubble there has remained one that promises to be of considerable importance both for long and short distance transmission. As is often the case, the present invention is the result of research in a new direction. Upwards of a year ago I was experimenting with some carbon contact points with a view to getting data of their action under different pressures and with various strengths of current. In one set of experiments I was surprised to observe a steady movement of the galvanometer, indicating a gradual increase of resistance in the circuit, and as the opposite effect was expected I was led to examine closely into the cause of this action. Arranging the contact points in such a manner that they could be examined by a powerful



FIGS. 1 AND 2.—CUTTRISS' TELEPHONE TRANSMITTER, WITHOUT ELECTRODES.

magnifying glass, it was observed that on the first application of the battery there was a good surface contact between the carbons, but that as they expanded under the heat the surface gradually became raised until, at last, the contact was so exceedingly small that it became incandescent for an instant. At the moment of incandescence the contact points fell together again, and the action was repeated, the whole cycle taking about 30 seconds, and in some cases it would keep on repeating with great regularity for 20 minutes, or more, before the points became so much changed as to stop the action. While it was interesting to observe this action it was on the other hand very disappointing, as it showed the impossibility of using the contacts for the purpose intended.

I was then led to try a number of contact discs, but here I was met by the difficulty that with the light pressure I was using—only from 2 to 10 grains—the various discs would never resume their former condition after the removal of the pressure. It was at this time that I realized that the only way to get around the two difficulties would be to make such an arrangement that each contact should have a tendency to spring open and at the same time preserve continuity of circuit. After trying numerous devices without success it occurred to me that a helical carbon spring, if such a thing could be made, would offer the best solution of the difficulty.

For upwards of a month I had a maker of incandescent lamps trying to produce some of these helices, but without success. I then determined to try it myself; so, with an Edison fan motor geared direct to a fan rigged up out of a tin can, an improvised Fletcher's blow-pipe and a small circular crucible furnace, I went to work, and in a few hours had got my first helix. But, as may be imagined, it was too ethereal for the rough and tumble of this world.

Nevertheless, it showed that I was on the right track and after a few days' practice, little trouble was experienced in turning out about anything I desired. I now have the carbon helices of such resistances that when closed in their natural condition they have a resistance of about 10 ohms; but when fully distended the resistance is upwards of 500 ohms, and a movement of .01 of an inch tending to open the convolutions makes a variation of from one to two hundred ohms. Their action on the instrument for which they were designed was perfect and no sparking could be observed between the convolutions until the battery was increased to such an extent that the whole helix was heated to some 300 or 400 degrees Fahrenheit.

This absence of sparking under heavy battery at once struck me as a valuable feature in a telephone transmitter and as the battery circuit could never, under any circumstances, be interrupted, there should be an absence of those ear-breaking kicks which are so often experienced when impatience is expressed at the distant end.

As a result I devised the simple arrangement shown in the accompanying engravings. As will be noted in Fig. 1, the helical carbon spring C is permanently cemented to the diaphragm and presses against the end of a screw S, to which it is also permanently connected and by which its tension can be regulated and the convolutions of the helix brought nearer together, or separated, as desired. The carbon helix is shown enlarged in Fig. 2.

Experiments proved the correctness of my theory and not only does the instrument transmit speech loudly, but the enunciation is so remarkably clear that I have been led to look for some particular reason why this should be so. I think it will be found to be owing to the extreme lightness of the helix (generally less than one grain); to the absolute continuity of the circuit—that is to say, the elimination of electrodes—and also to the fact that as each part of the spiral is tending to open itself it absolutely precludes any tendency for the surfaces to jam or lock together.

"CONDUIT WIRING."

BY

Augustus Noll

THE methods, heretofore employed, in fitting buildings for electric lighting for future service, were at once costly and unsatisfactory. The wires, were brought to all the outlets, and connected to the main and feeder wires by means of cut-outs or safety devices, grouped in central points; the main feeders were brought to a point in the front of the cellar, and the wires were usually imbedded in the plaster.

After a few years, a lighting company having been organized to supply electricity, in any city, the owner applies for connection of his building with their system under the impression that the only requirement and expense is the small cable which connects the street mains with the main wires in the cellar. He usually receives a report, after his premises have been inspected, that: *The* *wires are not large enough; or it is wired on the two-wire system, and we require three; or vice versa; or the lines are grounded, due to the deterioration of the insulation, and numerous other faults.* To remedy these defects, usually, is as expensive and more troublesome than the original work, and the work at best then is "botched." The building, as noted above, was "wired" for so-called "future use," and as shown, it is usually a gamble, as far as satisfactory results are concerned. The character of the work is neither permanent nor finished.

By the use of conduits, these defects can be overcome. Instead of "wiring" a building for future use, "conduit it."

The cost is less than one-half; the work is permanent, and can be installed in such a way, that in future, any system of lighting can be used. The wires need not be installed until there is immediate use for them, and then only in the parts of the building it is intended to light. The insertion of the wire in the conduit, can be made quickly and without cutting or defacing the plaster or wood-work in the building.

The conduits should be installed in such manner that the channels will be continuous from the outlets to the cut-out or distributing boxes, thence to the main floor-box, and the next end to the front of the cellar. They should be of ample size, and a sufficient number provided to allow placing only one wire in a tube. One or more receptacles, according to the size of the building, should be provided in the walls, and should extend the whole height of the building. The location of these should be central as far as possible.

Angle and fishing boxes should be inserted liberally, for purposes of access, location of cut-outs, and to simplify and make easy the insertion of the wires.

At least two large tubes should be run to each floor in each recess, and in large structures an extra pair should be run in each recess, extending to the top floor. At each floor, and fitted in the recess, should be placed the main floor fishing box, fitted with sockets for the entrance and departure of the tubes, and also fitted with a cover, the surface of which should be flush with the surface of the plastered wall; the smaller boxes being finished in like manner, gives a finished appearance to the work.

In buildings, where the lamps or "points of lighting" are subject to continual changes, such as office buildings, etc., due to subdivision of offices, erection of partitions, etc., a good plan would be to provide a separate feeder for each office, placing the main box on the side-wall, in the corridor, and from that box, carry two or more conduits, according to the size or number of lights, on all side-walls of the office, locating the tubes either behind or directly under the cornice, and at certain intervals, insert a box. In these boxes can be located the cut-outs, and all branch or tap connections can be made therein. This will obviate the necessity of defacing the side-walls and ceilings, will simplify the system, and add to its appearance. Should the present tenant vacate the office, the changes in the location of lights, to meet the requirements of the next, can be made quickly, cheaply, and without annoyance, either to the owner or tenant, also without interruption to the lighting system installed in the other offices or public part of the building.

A conduit system installed in this manner will meet the requirements of either the two or the three wire systems, direct or alternating current, and the electromotive force used can be either 50, 100 or 200 volts; and at the same time, it gives the owner his choice, and does not limit him to the use of any one system, to which his building is fitted, as in the previous methods.

The work if properly installed, and good materials are used, will be permanent, safe and cheap.

It is conceded by all experienced in the art of artificial illumination, that the method employed in obtaining it by means of electricity is the safest. It is the aim of all interested in the art, to provide safeguards. The fire underwriters have received our hearty co-operation, and the result of our combined efforts have been such, that at the present time, a building can be fitted for an electric lighting system, which is safe and permanent, and which affords few chances for interruption to a steady light.

The Board of Fire Underwriters insist upon the use of a system of wiring which includes all possible safeguards, but the consumer insists not only upon the use of a system which is free from dangers of fire, shocks, and large bills due to leakage; but also, upon a system that will afford steady and uninterrupted light at all times, and for which he is willing to pay.

Every improvement in installation work, either in materials, method or appurtenances, has increased the cost, yet the work increases in volume every year; electric light is gradually covering the field, to the exclusion of all other artificial illuminants.

Being willing to pay for the best system of "installation work," the consumer is entitled to that which experience has taught us gives the best results in matters of safety, permanence and reliability, and which is in the end the cheapest. This experience will compel us to adopt the "conduit wiring" system, which is conceded by all electrical engineers to be the best; but, do we give the consumers the best, even when we adopt the conduit system, and place two wires of different polarity in one tube? Is it the safest, most permanent and reliable?

The conduit manufacturer, when exhibiting his product, inserts wires of different polarity in the tube and in turn, arcs, short circuits, and overloads them; but forgets that the consumer is principally in need of a good lighting system. *It is light, and such light that won't go out,* he wants, and it is reasonable to suppose that if each wire is provided with a separate conduit, the desired result is obtained.

The consumers not only want a safe system, but one that affords very limited chances for short circuits, arcs, etc., and when two wires of different polarity are placed in one tube, these elements of danger and interruption are invited. Two wires placed in a tube and exhibited in a show-room may be safe enough, but would any one be rash enough to do so, when installing a plant in a brewery, or in a building where gases are generated? Excessive moisture in the brewery, and explosive gases in the other building, would from experience, teach us to provide a conduit for each wire, and in addition to this, to use only such wire, having an insulation of the very highest grade.

The conditions, under which the work is placed, comparing the first with the last two noted, are, I admit, extreme, but, comparing the last two with those under which conduit wiring is installed, in general practice, are the conditions so dissimilar? In the first, we are confronted by moisture; safeguards are provided against this, not on account of the danger of fire, so much as excessive interruptions to the lighting system. In the other, the danger lies in the gases which are generated, and in case of a short circuit, though the metal strip may fuse and break the connection, still an explosion may occur, due to the spark or flash created at the time of short circuiting.

Are not these same conditions met with, to a greater or lesser degree, in every installation? Is there a building, where it can with safety be assumed that the conduits will, at all times, be absolutely free from moisture and gas?

This can best be answered by the fact that some of the most careful and experienced contractors and electrical engineers throughout the country, now insist upon figuring on placing only one wire in a tube, when asked to submit proposals for installation work. The general results obtained, by placing two wires in one tube, have been very unsatisfactory, and the experience costly. While the first cost is greater, when inserting only one wire in a tube, still, the annoyance and cost of repairs will in a few years, more than offset the difference in first cost between the two methods.

Time has shown, that two wires placed in a tube invite short circuits; that the work is unsatisfactory; that the interruptions are of such frequency, that no dependence can be placed on the light; that the work is, to say the least, temporary, and in many cases where the service has been unsatisfactory, a separate conduit for each wire would have obviated the causes thereof.

The gas and water pipes, placed in buildings are not supposed to leak, nor is such leakage supposed to enter the conduits used for electric light wires, but it does, and to a very great extent. The moisture which enters may be only a source of annoyance and expense, but the presence of gas is dangerous.

One of the strongest claims that is advanced by the manufacturers of interior conduits in favor of the conduit system, is the simplicity, cheapness, and absence of annoyance, when making changes in lighting system or increasing the number of lights on the various circuits.

With the twin-conductor system, the increase of lights is limited to a great extent. The Board of Fire Underwriters limit the amount of current to be carried on duplex wires inserted in conduits, and should a consumer change from a 100 volt system to a 50 volt system, and at the same time increase his lights, his margin will be very small unless the tubes are unusually large.

That the National Board of Fire Underwriters had misgivings as to the use of twin conductors in a tube, is evidenced from the fact that in their rules (June 10th, 1890) they limit the carrying capacity to five amperes. The committee on wiring appointed by the National Electric Light Association, submitted their report at the last meeting (Montreal, Sept., 1891) and recommended that "Conduits must not be supplied with a twin conductor in a single tube, where a current of more than 10 amperes is expected." From data, which is daily accumulating, I believe it is a matter of only a short time, when its use will be prohibited entirely, and that the "single-conduit, twin-conductor system," will follow in the wake of "undertakers," and other low-grade insulated wires.

A system of conduit wiring can be installed, that will equal gas piping in permanence, but it can only be done, by using the best conduit, and the highest grade of insulated wire, and providing a separate duct for each wire.

Experience has taught us, that for electric lighting purposes, no place is dry enough to permit the use of inferior insulated conductors, and that the best is the cheapest; this applies equally as well to conduits. The conduits are installed under the same conditions as wire, and the same care must be taken.

Some years ago, the writer was consulted, regarding a large wiring contract, by the officer of a lighting company, on the matter of insulated wire; the writer suggested the use of a certain insulation, which in his opinion has no superior; an electrical engineer who was present, suggested the use of inferior grades in such places as small stores, etc., in side streets, claiming that in these cheap places a cheaper wire can be used, and so save money for the company.

The writer answered that it was just in the cheap places, that the best wire should be used, the dangers being greater than in the better constructed buildings on the main thoroughfares. That the officer of that company appreciated the importance of using the best grade wire, and that the position then taken by the writer was a strong one, is attested by the fact that to the writer was awarded the contract, in a clause of which it stated "that the contractor was to guarantee the work for a period of one year, from the time of turning on the current," and although several years have elapsed, there has not been one cent expended in repairs, due to the insulation on the wires. The contract covered all kinds of work, and in all parts of New York City, and included residences, theatres, stables, bakeries, etc.

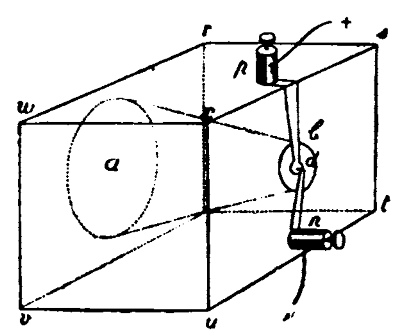
This officer, while not an electrician, possessed a large business experience, which no doubt taught him that, by protecting his customer, he was protecting his company. Had inferior wire been used, no doubt the loss to the company, in decreased monthly receipts, due to the interrupted service, and the employment of a repair gang, would have more than offset the difference in first cost.

TELEPHONE TRANSMITTER PATENTS.

BY THALES VOLTA BLACKSTONE.

In the opinion of many persons who may be presumed to be competent authorities, the fuss which has been made over the recent issue of the Berliner microphone patent seems out of all proportion to its real importance. The hysterical editorials which have appeared, not only in the daily newspapers, but even in technical journals whose editors might be expected to know better, betray a phenomenal ignorance of the subject which is occasionally highly diverting. As a matter of fact, Mr. Park Benjamin, in his letter recently printed in the *Evening Post*, came very near making a centre shot, in the following felicitious observation, which is quite too good not to be quoted:—

> If Reis invented Berliner's structure and Bell taught the world how to use it long before Mr. Berliner applied for his patent, an anxious public will wait somewhat breathlessly to hear the Bell Company's explanation of what there was left for Mr. Berliner to invent.



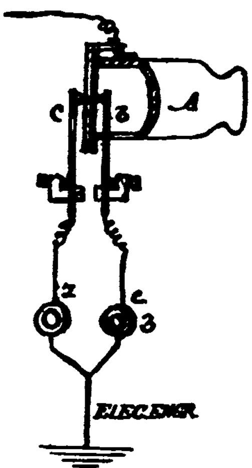


FIG. 1.—REIS TRANSMITTER. FIG. 2.—EDISON TRANSMITTER.

One anwer to this conundrum may be found in the testimony of Thomas A. Edison, given by him while being cross-examined by Mr. Betts in the telephone interference cases some years ago. Referring to an experiment which had been made by him with the Reis-Legat transmitter about July, 1876, Mr. Edison was asked:

> *Q.*—Did you succeed in transmitting any words with it at that time?
>
> *A.*—I can't say; *we generally knew what was coming*, and knowing what was coming, even a Reis transmitter pure and simple, transmits and reproduces sounds which sound almost like that which was being transmitted, but when it was attemped to transmit something which the receiver did not know, *it was very seldom that any word was recognized.*

Those who have tried it will recognize this as a faithful description of the performance of the "Reis transmitter pure and simple."

The testimony of Mr. Edison, however, is scarcely needed to establish the fact that the Reis instrument "pure and simple" is one which is absolutely worthless for any commercial purpose, notwithstanding that more than one learned university professor has hopelessly stultified himself by giving sworn evidence to the contrary. *It has never yet been demonstrated in the presence of a court of justice that the Reis apparatus "pure and simple" is capable of transmitting a single intelligible sentence,* notwithstanding that such a demonstration, if it could have been made, must have conclusively disposed of the celebrated "method claim" of the Bell patent.

Mr. Edison was further asked, in the course of the same examination:

Q.—What specific addition or modification of the Reis instrument, as described in those publications, is necessary to adapt it to transmit articulate speech?

A.—I have found that carbon placed between the electrodes makes it a very good transmitter.

Q.—If one of the electrodes of the Reis transmitter, as described in those publications, was made of carbon, would it then be adapted to the transmission of articulate speech?

A.—Yes, sir.

Now, what was the Reis apparatus, "pure and simple?" In the Annual Report (Jahresbericht) of the Physical Society of Frankfort-on-the-Main, for 1860-61, Philip Reis published an article "On Telephony by the Galvanic Current." A translation of a portion of this with a fac-simile of the accompanying illustration will show exactly what he had done at that time:

From the standpoint of the preceding principles, I have succeeded in constructing an apparatus by means of which I can reproduce the tones of different instruments; yes, and even to a certain degree, the human voice.

In a cubical block of wood, Fig. 1, *r s t u v w x*, is a conical aperture *a*, closed at one end by the membrane *b* (made of the lesser intestine of the pig), in the centre of which a little piece of platinum is cemented as a conductor of the current. This is united to the binding-screw *p*. From the binding-screw *n* there proceeds also a thin strip of metal over the middle of the membrane and terminates in *a little platinum wire which stands at right angles to the length and breadth of the strip*. From the binding-screw *p* a conducting wire leads through the battery and to the distant station, terminating in a helix of copper wire overspun with silk, which in turn connects with a return wire that leads to the binding-screw *n*.

Now we may see, as Mr. Benjamin puts it, exactly "what remained to be invented." Substitute for the little platinum wire which stands at right angles to the length and breadth of the strip," a *carbon point*, and we have the precise structure which Mr. Edison said he had found to be "a very good transmitter."

It therefore becomes an interesting subject of inquiry as to *who* invented that "which remained to be invented." The particular thing does not appear to be visible in the claims of the recently-issued Berliner patent. On the contrary, the indications are that the much-sought-for Ethiopian is concealed in an entirely different part of the woodpile; a part which has hitherto apparently escaped the attention of searchers.

On July 20, 1877, Mr. Edison filed an application in the Patent Office for an "Improvement in Speaking Telegraphs." He says in his specification, referring to the drawing, a copy of which is given herewith, Fig. 2:

The object of this invention is to transmit the human voice over telegraphic wires for conversational purposes. . . . . A is the resonant chamber over the end of which the diaphragm is stretched, . . . *b c* are two contact-springs, having points made of compressed plumbago, mixed preferably with gum-rubber, but any substance not liable to rapid decomposition may be used; these points face each other on the opposite sides of the diaphragm, and make contact with platina disks secured to the diaphragm. . . . . As plumbago decreases and increases its resistance enormously under slight changes of pressure, it follows that the strength of the electric waves will be in proportion as the speaker's voice is strong or weak. . . . The point *b* may be dispensed with on very short lines.

This structure is also shown, in practically identical form, in Fig. 10 of Edison's British Patent of 1877.

This application was put into interference with an application of Berliner filed June 4, 1877, the following being the point in issue, as officially formulated:

In a telegraphic apparatus operated by sound, the combination with the diaphragm, of one or more contact points of *plumbago or similar inferior conductor* in the electric circuit, whereby the rise and fall of electric tension is proportionate to the pressure exerted upon the said point or points by the diaphragm.

It will be seen that this issue involves precisely the thing which, in the words of Mr. Benjamin, "remained to be invented" to convert the apparatus of Reis into a commercial instrument.

What has become of this interference? The writer is not in the secrets of the Patent Office nor of the Bell Telephone Company, but he has made diligent inquiry respecting this matter among those who might be expected to know, without eliciting any very definite information. He has searched the archives of the Patent Office in vain for any record of the decision of this interference, and the obvious inference is that it must be still pending.

If this be the fact, and priority of invention should ultimately be awarded to Mr. Berliner, we shall have the answer of the Bell Company to Mr. Benjamin's conundrum. To conclude, therefore, the following propositions are submitted:

1. The Reis transmitter, "pure and simple," is not a commercial instrument.

2. The Reis transmitter, plus Edison's (or Berliner's) carbon electrode, is a commercial instrument.

THE LIGHTING OF RESIDENCE DISTRICTS.

BY

W. S. Barstow

In the history of every company, electrical or otherwise, there comes a time when it is necessary to extend its business; and this extension is often unprofitable for some time after its start. When a corporation is already showing net earnings it is a source of displeasure to the stockholders to be obliged to relinquish any portion of the present earnings for the prospect of increased earnings at a future time.

Electric light companies, in order to prove that the claim of "light and power for the public" is a just one, find it necessary to enter residence districts and supply current on the same basis as gas. It is an unfortunate undertaking for any dividend-earning company to erect and endeavor to maintain a central station in a residence district, with the expectation of net earnings therefrom during the first or second year. The business man is willing to pay for commercial lighting a sum which he would never think of paying for the lighting of his residence. He will, however, install 10 lights in his dwelling to one in his place of business, although he may only use one out of the 10. Thus the lights burning in a residence district are only a small percentage of the lamps installed. The maximum load of a station in a residence district is actually about 25 per cent. of the lamps installed or connected, while that of a station situated in a business section of a city is never less than 50 per cent. This means, that in a residence district we must connect twice as many lights as in a business district to get the same income. Another unfortunate thing in residence lighting is the fact that during four months of the year the dwellings are closed, and during the months they are occupied the light is only used about five hours out of the 24. The company, like the winter-hotel manager, is obliged, at the start at least, to make up the interest on its investment for the summer months out of the earnings of the other seven.

It therefore follows that a company operating in a residence district must endeavor to either increase its earnings as much as possible during the winter months in order to offset the loss during the summer, or so reduce the cost of current that the receipts balance the expenses during the summer months. As the former depends on the popularity of the light, and the popularity depends to a considerable extent on the cost, it is evident that every effort must be made to reduce the cost of operation so that receipts balance expenses during unprofitable months.

The fact that current can be supplied more economically from a station already in paying operation than from a station having heavy operating expenses to start with, needs no emphasis, as current generated in quantity with large units working efficiently is more economical than current generated in a number of small units. Thus it only remains to be ascertained what we can afford to lose in conductors. And in order that this point may not be considered entirely theoretically it might be of value to those interested in this subject to know what has been actually done in this direction from a practical standpoint.

The second district system of Brooklyn is laid out similar to any ordinary Edison three-wire central station system of underground conductors; each feeder is brought to a central point of distribution situated on land owned by the company, so that in the event of the load warranting the operating of a station in after years no change in the feeders will be caused by its erection. From this central point of distribution a large feeder is laid to the First District station, a distance of about two miles. The question arose before the work was begun, At what load would the economy of transmission on this feeder be overbalanced by the loss in the conductors and interest on any special apparatus required? To answer this question, the cost of labor, interest on investment, and deterioration of a new isolated station must be balanced against increased cost of

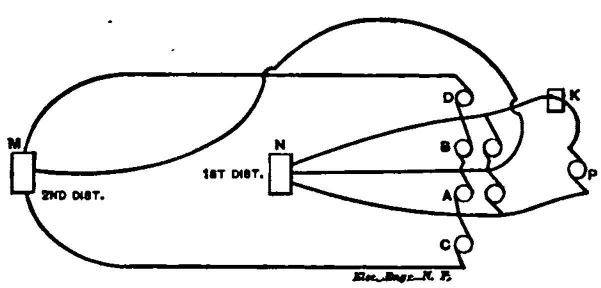


FIG. 1.—METHOD OF DETERMINING LOSS IN TRANSMISSION.

labor in old station, interest on investment, deterioration, and the loss in transmission—the cost of fuel, water, etc., remaining the same in either case.

The following equations may present this more clearly:

$$\overbrace{\text{Cost of labor} + \text{Interest on investment} + \text{Deterioration}}^{\text{Separate Station}} = \overbrace{\text{Increased cost of labor in old station} + \text{Interest on investment} + \text{Deterioration} + \text{Loss of transmission.}}^{\text{Feeder Transmission.}}$$

In the above equation the interest on investment + deterioration is generally equal by both methods, so that we have:

$$\frac{\text{Separate Station}}{\text{Cost of labor}} = \frac{\text{Feeder Transmission}}{\text{Increased cost of labor + loss of transmission}};$$

or, cost of labor (in separate station), *minus* increased cost of labor (in old station), *equals* loss in transmission.

By substituting the figures for the items in the last equation it will readily be seen when the loss in transmission becomes greater than the cost of operation of a new station. For example, the cost of labor in a separate station for 24 hours would ordinarily be

2 engineers	$6.00
2 firemen	5.00
2 dynamo men	5.00
	$16.00

While the increased cost of labor in an old station (one already in operation) for 24 hours would ordinarily be

1 engineer	$3.00
1 dynamo man	2.50
	$5.50

Therefore, $16.00 *minus* $5.00, *equals* loss of transmission, or, $10.50 *equals* loss in transmission. That is, until the loss in transmission for 24 hours a day throughout the year exceeds $10.50 (in current only), it is preferable to transmit current rather than to generate a separate supply.

In order that we may reckon the loss in transmission in dollars and cents it is obvious that we must have some way of securing a tangible record of this loss. An exact, recorded measurement of the loss can only be obtained by separating the current supplied into two distinct parts—one, the current actually consumed at the lamp; the other, the watts lost in transmission. When divided in this way we can easily meter the loss and thus keep an exact account.

After a year's successful operation by the Brooklyn Company in its new district, described by the writer in THE ELECTRICAL ENGINEER of May 6, 1891, the following plant has been devised whereby it is possible to correctly record the loss of power in transmission to the new district. The arrangement is as follows:

In the diagram Fig. 1, M and N denote the centres of distribution of the two districts, in which N is practically the location of one station, and M is about two miles distant from this point. A and B are the two pairs of machines (more or less) on ordinary three-wire system, supplying current at 115 volts to N, to supply current to M (at the same voltage at lamps). Dynamos C and D are placed as shown in the diagram. The armatures of these machines C and D are wound for the maximum current supplied to M, the voltage being the maximum economical drop in transmission in feeder. These two machines are belted to a 230 volt motor P which is run from the main station bus. As may be seen in Fig. 1, C and D will generate whatever watts are lost in transmission in conductor to M, the watts furnished to the lamp at M being generated at A and B. In fact, in action, C and D are nothing more than electrical (hydraulic) rams raising the pressure of the current delivered by A and B. By making C D series machines they become entirely automatic in regard to the regulation of the pressure necessary to counter-balance the drop in the feeder.

In the motor circuit a meter is placed at K, and this gives us the total loss in transmission + the inefficiency of the transforming device, and by subtracting the latter from the total reading the actual loss in the conductor may be obtained. In transmitting 300 amperes to M, the average day load in the residence district, the pressure of C or D is 10 volts. The actual cost of a year's loss in transmission is as follows:

Winter (7 months)	*Week-day loss.*	
	11 P. M. to 4 P. M. =	1.52
	4 P. M. to 11 P. M. =	2.80
	Total,	$4.32
	Sunday and holiday loss.	
	11 P. M. to 4 P. M. =	.48
	4 P. M. to 11 P. M. =	.98
	Total,	$1.46
Summer (5 months)	*Week-day loss.*	
	11 P. M. to 4 P. M. =	1.56
	4 P. M. to 11 P. M. =	1.40
	Total,	$2.96
	Sunday and holiday loss.	
	11 P. M. to 4 P. M. =	.32
	4 P. M. to 11 P. M. =	.42
	Total,	$0.74

Average loss per day during the year.........	$3.36
Total loss per year...........................	$1,227.68
Total loss allowed (efficient loss)............	$3,832.50

By calculation of total number of lamp-hours (of 8,000 lamps connected) and receipts, the cost per lamp-hour at the centre of distribution in the new district two miles from the generating centre is 10 per cent. more than at the generating centre.

The above figures need no explanation as to the financial efficiency of low-tension transmission. Of the 8,000 lamps connected 5,000 are located 2,500 feet from the distributing point of this district, or about two and a half miles from the generating point; 1,000 lamps and 60 h. p. in motors are connected 5,000 feet from the distributing point, or three miles from the generating point!

Fig. 2 is a diagram of an average daily pressure at the main station-end of the transmitting feeder. The constant for this diagram is 7.82 amperes = 1 volt drop (each volt above 117). This gives one-half the load of the feeder at 117 volts.

In the manner above shown, new districts may be entered without serious loss in earnings, and whenever the district becomes so loaded as to pass the point of economy by transmission, a station can be erected which from the very start will have a good paying load. The feeder may then be turned into new territory or left as a tie-line between the two stations. The advantages of this system for residence lighting will be appreciated by all companies who have struggled along turning over the net earnings of one station to make good the deficit of another.

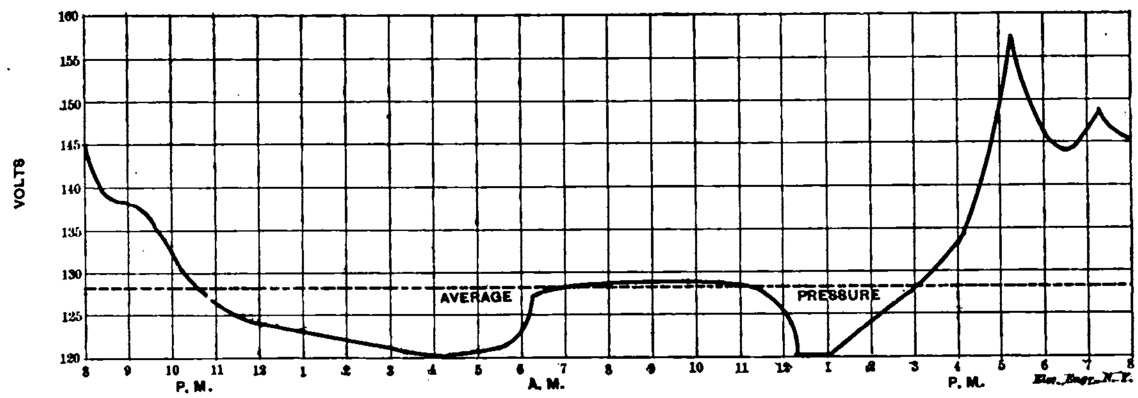


FIG. 2.—CURVE SHOWING AVERAGE PRESSURE OF TRANSMITTING FEEDER AT MAIN STATION.

THE HUM OF MOTORS.

BY

Chas J. Hayes.

As to the cause of the humming of motors, I would offer the following explanation: We know that all sound is produced by vibration, hence there must be produced somewhere in the motor, sufficient vibration to cause sound. The question is, How and where is the vibration produced?

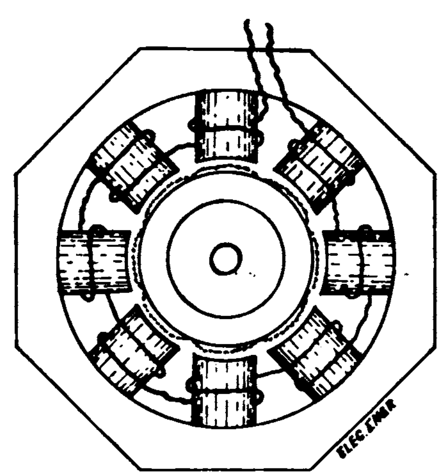
Take for illustration an eight-pole motor with Gramme ring armature, with armature winding removed. The humming action would be the same with winding on or off, as demonstrated by Mr. Huff in his experiments,[1] but for clearness in the accompanying figure I take it with the winding off.

Now, if a strong current be passed through the coils of the field-magnets, the armature being at rest, that portion of the iron of the armature core lying directly in front of the poles, will be strongly attracted and slightly raised, against the resistance of the iron of the core, above those portions lying in front of the spaces between the poles, as shown, magnified, by the undulating dotted line in the figure.

The distance to which the surface of the iron will be raised is, of course, imperceptible without the use of very delicate and exact measuring instruments, the amplitude of vibration necessary to produce sound being very small.

Now, by revolving the armature, it will be seen that every part of its circumference will be brought in succession in front of each of the poles and consequently attracted and slightly raised as it passes, producing a progressive undulatory movement of the iron of the ring, like waves on a body of water. And if the speed of the armature be sufficient, this movement, or vibration, will become audible, producing a musical tone, depending for its pitch upon the speed, and for its intensity upon the degree of magnetization of the field. This appears to be the action that takes place in all motors that hum, but, of course, the more poles a motor has, the less speed required to produce a given pitch.

The quality of iron used in the armature, particularly its



HUMMING ACTION IN MOTORS.

degree of elasticity, would somewhat affect the tone produced. The movement of the molecules of iron upon each other, necessary to produce this vibratory movement, is one of the probable causes of the heating of armatures.

I would suggest wrapping the armature loosely with a piece of unshellacked cloth before winding, as being likely to somewhat deaden the vibration or at least muffle it. Can any one suggest some other remedy?

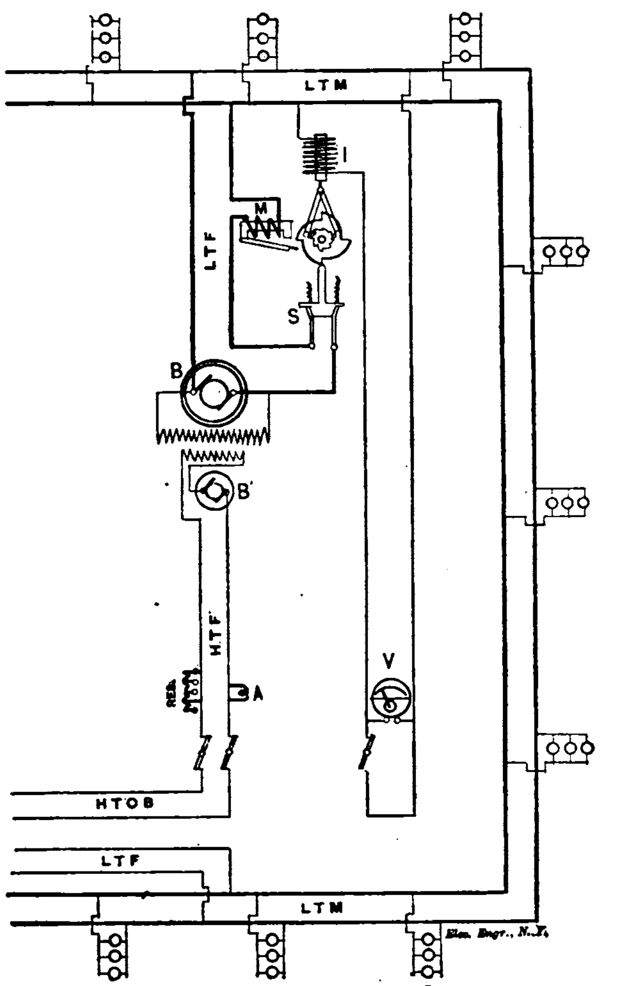
1. THE ELECTRICAL ENGINEER.

DISTRIBUTION OF ELECTRICITY AT OXFORD.[1]

The system of electrical distribution that is being adopted by the Oxford Electric Supply Company will be watched with interest by electrical engineers, having been designed with the object of placing the continuous-current motor-generator on an equality with the alternating-current transformer in the matter of manipulation and control.

The local authorities, stipulated that continuous currents should be employed, and as the generating station is situated at a distance of about 1,200 yards from the centre of the area to be supplied, a high-tension converter system became necessary, and 1,000-volt continuous-current generators with continuous-current transformers to convert to 100 volts and feed into a network of secondary mains, were adopted.

The main feature of the system is the arrangement



Distribution by Motor Dynamos at Oxford.

whereby all the transformers in a district to be supplied can be completely controlled, stopped, or started, from one switchboard situated in the middle of the district; the high-tension current being supplied from dynamos running in parallel at the distant generating station to omnibus bars on the switchboard from which it is distributed through separate switches to the high-tension armature of each transformer. A voltmeter above each switch is connected by pilot wires to the point in the secondary network at which the low-tension armatures supply current, and the high-tension and low-tension armatures of the transformers are connected and disconnected from the high-tension omnibus bars and low tension network, respectively, according to the number of lights in use at one time, varying the number of transformers running with the conditions of the load during each part of the day. In this manner it is never necessary to run any transformer with less than 50 per cent. of its full load, and as the machines as constructed yield an efficiency of 84 per cent. at half load and 90 per cent. at full load, it is expected that the total efficiency of distribution will be very high.

As the number of lights in use increases, the transformer, situated at the switch station, is connected to the high-tension omnibus bars and its low-tension armature to the nearest point in the secondary network. Separate voltmeters are connected to the low-tension mains at the points at which the distant transformers feed into the network. When these voltmeters show that the E. M. F. on the low-tension mains is below the normal, the transformers are started up one by one, as shown in the accompanying illustration, which gives one distant transformer, and the switches at the switch station for controlling it.

The high-tension feeders, as shown in the accompanying diagram, are connected to the omnibus bars by means of the double-pole switches, the regulating resistance preventing a momentary excess of current. The current is supplied to the armature through a few turns of highly insulated wire wound round the magnets of the transformers, which partly magnetizes the field, and passing through the high-tension armature causes the transformer to rotate when the low-tension armature generates an E. M. F., and the main magnetizing coils, being connected as a shunt across the low-tension armature energizes the field to the full extent. The resistance is now cut out of the high-tension circuit until the E. M. F. on the secondary armature is equal to the E. M. F. on the low-tension mains, as indicated on the voltmeter, V. The low-tension armature is then switched on to the mains as follows:

One of the voltmeter wires is connected to the mains through the winding of a magnetic switch, shown diagrammatically at S, the small current constantly passing through the voltmeter being insufficient to affect the switch. A switch is arranged at the switch station to short circuit the voltmeter, which allows the full current required by the magnetic switch to pass through the wires and cause the magnet, I, to ascend, when the circuit is again broken at the voltmeter switch, allowing the magnet, I, to descend again. The double movement rotates the cam wheel through $\frac{1}{8}$th of a revolution, and pressing the contact piece into the brushes of the switch, S, thus connects the low-tension armature to the low-tension mains. The voltmeter, only being momentarily short circuited, reads, as before, across the mains. The E. M. F. on the voltmeter is kept constant by means of the regulating resistance in the high-tension feeders, and the transformer is disconnected from the mains when the amount of current being supplied, as indicated on the ammeter, A, falls below a certain amount.

On disconnecting the transformer again, the resistance is once more inserted until the current falls to zero, indicating that the E. M. F. on the secondary armature is too low to supply any current to the mains; the switch S, is then broken by again short circuiting the voltmeter, rotating the cam wheel through another $\frac{1}{8}$th of a revolution and allowing the springs to pull the contact piece from the brushes. Thus there is no sparking at the brushes of the switch, S, as under ordinary circumstances the circuit through it is never broken while any current is flowing. The magnet, M, is connected to the low-tension feeders in such a manner that should the low-tension armature be switched on to the mains before the high-tension armature or before the low-tension armature is giving sufficient E. M. F., the excess of current flowing back from the low-tension mains will cause the armature of the magnet, M, to be attracted, knocking round the cam wheel slightly and breaking the circuit at S, again, but leaving the switch ready to be "made" again when necessary from the switch station.

By the above means each distant transformer is as completely under the control of the attendant at the switch

1. London *Electrical Review*.

station as the transformer fixed at that station, and as the oiling is automatic by means of oil pumps on the armature shaft, the transformers themselves will only require inspection every three or four days.

The plant to be first installed at Oxford will be capable of supplying 7,500 running lights of 32 watts each. The buildings for the generating station are making good progress, and the current will be supplied early in the new year.

The details of the circuits, &c., are due to Mr. Thomas Parker, works director of the Electric Construction Corporation, and J. H. Woodward and E. and G. Rees.

A SIMPLE METHOD OF LOCATING ARMATURE DEFECTS.

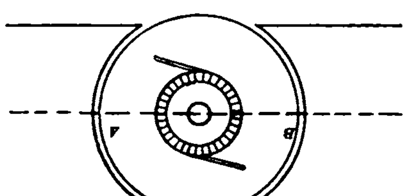
BY

Osborn P. Loomis

All electricians are aware of the many trials of searching for an armature "short-circuit." One method is to run the armature by the usual belting and excite the field; then by observing the heated parts some idea may be obtained where to commence searching for the trouble. It will be understood that the above will only apply to the short-circuiting of a few coils, for when the whole, or nearly the whole, armature is closed on itself by the two adjacent wires touching, running in an excited field will warm all of the wires and, of course, no locating is possible. To add to the trouble, the machine must be belted up and run, which takes time, and repeated trials become very annoying.

I will now describe a method, devised by the writer, which at times has been very convenient. No arrangement for belting need be made; it is only necessary to fasten a monkey-wrench to the rim of the pulley, or, better still, a crank to the end of the shaft. Now excite the fields and, to make the effects more marked, connect the coils in parallel as the excessive current will only be used for a moment. When this has been done the strongest man will scarcely be able to rotate the armature, and then only with extreme slowness, except at one position. When this position has been found, mark the armature at points in the centre of the pole-pieces A, B, as shown in the accompanying diagram, and at both ends of the armature.

The explanation is that both halves of the armature op-



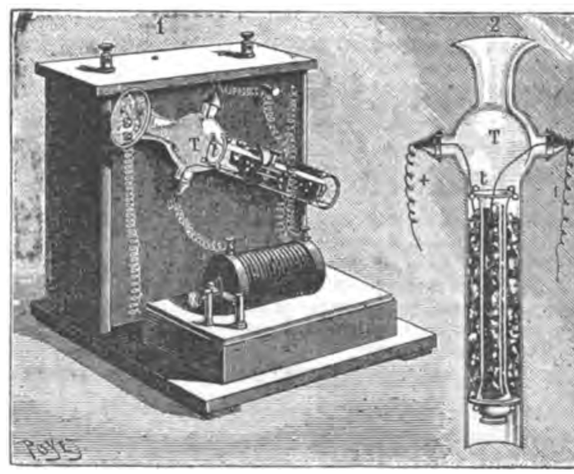
LOCATING ARMATURE DEFECTS.

pose one another at this position; but when not at these points a continuous circuit is formed and the resultant magnetic effect is enormous. As the "cross" will be found at one of these four marked points it becomes desirable to know in which one it is most likely to be found. Experience has shown that it is nearly always on the commutator end in the last half of the winding where the wires pass down through the first half terminals. In armatures where the windings are equal, I suppose it would be as liable to be at one point as at another.

With this method a defect can be found and remedied in a few moments, for it has always been a simple matter to repair it when discovered. These results can be observed in a perfect armature by connecting the opposite sections of the commutator. When only one coil is short-circuited, the magnetic effect is much less and the points must be marked 90° from the ones shown, but these cases are few and are soon discovered in other ways. The above will be understood to apply to armatures of the drum type with Siemens winding.

THE GIRERD ELECTRICAL APPARATUS FOR GENERATING OZONE.[1]

The valuable properties of ozone as a disinfectant are so well recognized that a simple apparatus for generating it will tend to increase the application of this valuable



GIRERD'S OZONE GENERATOR.

agent, which has now become a recognized factor in the destruction of disease germs. A simple and compact apparatus of this sort has recently been constructed by Dr. Girerd and is illustrated in the accompanying engravings. The apparatus is so constructed as to furnish air not only with ozone, but also with a metallic vapor. Starting with the principle that the quantity of ozone generated is directly proportional to the air acted upon, that is, to the surface of the electrodes and also to the current, the inventor employs gold or aluminum foil. These fine sheets are loosely packed and present an enormous surface in a small space. As shown in Fig. 1, the apparatus consists of two perfectly cylindrical and concentric tubes. The metal foil contained in the central tube *t*, Fig. 2, is connected to the wire and constitutes one of the poles; the other pole is formed by the arrangement of the metallic foil placed in the annular space between the tubes T *t*. The apparatus is operated by means of a small Ruhmkorff coil, giving a quarter-inch spark, and fed by three sal-ammoniac cells. The apparatus occupies a space only 8 inches square and is thus quite portable and very practical.

THE ELECTRIC LIGHT AND COMPRESSED AIR IN MUNICH.

It it stated that a German company has submitted a project for a compressed air installation in Munich, which in addition to supplying motive power is intended to provide for the electric lighting of the city. The total installation capital has been fixed at 4,200,000 marks, the total annual expenditure at 550,000 marks; the total length of the conductors will amount to 65,000 metres.

1. *La Nature.*

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VOL. XII. NEW YORK, DECEMBER 16, 1891. No. 189.

***Semi-contact*—*a phrase employed by a lawyer who knows nothing, to befuddle a judge who knows less.*—E. J. Houston.**

LIGHTING RESIDENCE DISTRICTS.

THE first efforts of every electric light corporation have been bent on securing what appeared to them at the time as the most profitable class of customers, and as a result we find stations started largely for the furnishing of current in business districts where the hours of lighting are long and the load from which is fairly constant over an extended part of the day. Hence, even at the present time there are comparatively few cities in which any systematic attempt has been made to introduce current for incandescent lighting into the purely residence districts. That the stand taken on this question by station managers in general is one hardly warranted by facts, indeed, that residence lighting can, on the contrary, be made a paying business, is thoroughly demonstrated by the excellent article of Mr. W. S. Barstow, appearing on another page. As pointed out by Mr. Barstow, the question resolves itself into determining the point at which the economy of transmission in a feeder running a considerable distance is overbalanced by the loss in the conductors and the interest on any apparatus acquired. This, of course, will vary with the amount of load at the distant point, and he shows by actual figures an example in which it is evidently more profitable to operate a long feeder, though involving considerable loss in transmission, than to operate a station at the distant point. The experience gained by the Brooklyn Company shows that the cost per lamp hour at the centre of distribution in a district two miles from the generating centre is only 10 per cent. more than that at the generating centre itself, due to the excellent method of operation adopted by Mr. Barstow. For those who have placed the limiting distance of successful low-tension distribution at a fraction of a mile, the operation of lamps and motors three miles from the low-tension generating point will appear somewhat in the light of a revelation. Mr. Barstow has certainly proved that station managers need not fear to open up new districts even though for the time being the location of a station in such districts may be unprofitable. Aside from this, however, the introduction of circuits into such districts cannot fail to create such a demand that the erection and operation of a generating station will be called for within comparatively short periods of time.

A LEGAL CONTEST OVER THE HYDROCARBON TREATMENT FOR INCANDESCENT LAMP BURNERS.

THE suit of the United States Electric Lighting Company against the Edison Lamp Company, which has been pending for more than three years and was heard last week before Judge Acheson in Philadelphia, is perhaps second only in importance in its relation to the incandescent lamp industry to the filament case recently decided by Judge Wallace in favor of the Edison Company. The complainant alleges an infringement by the Edison Lamp Co. of a patent granted to it in 1884, as assignee of Edward Weston, covering the process of the hydrocarbon treatment, or "flashing" of the carbon conductors of incandescent lamps, the process which Justice Butt, of the British High Court of Chancery characterized, in his opinion sustaining the Cheesbrough patent as "one of singular beauty and efficacy." The history of this patent is somewhat unusual. In 1878 Sawyer and Man and Hiram S. Maxim filed nearly contemporaneous applications for patents more or less fully describing this process. An interference was instituted, which was terminated in December of that year by an adjudication of the Commissioner of Patents as against Maxim in favor of Sawyer and Man, to whom a patent was accordingly issued, covering the process referred to. In May, 1881, somewhat more than two years after the issue of the Sawyer-Man patent, Weston made application for a patent for the same invention. After a vigorously contested interference, the Commissioner of Patents decided Weston to be the prior inventor as against Sawyer and Man and a patent was accordingly granted to him; being the one on which the present suit is based. Considerable difficulty was experienced by the complainant in its efforts to procure evidence of infringement, resort being finally had to the heroic expedient of summoning certain workmen from the Edison Company's lamp factory and compelling them to testify. The principal points relied upon by the defense were the insufficiency of the evidence in behalf of Weston to establish the fact of the completion of his invention at a date anterior to that of Sawyer and Man; an allegation of public use for two years by Sawyer and Man before the date of Weston's application, and finally that there had been no actual infringement on the part of the defendant;

it being contended that the limited use proven by the witnesses called by the complainant, was merely an experimental and not a commercial use. The case was argued with much ability on both sides, the arguments occupying a greater portion of three days. An abstract of the proceedings is given elsewhere in this issue. It is thought that a decision will be reached within a few weeks.

MEASURING ALTERNATING CURRENTS.

BESIDES the variety of apparatus necessary for its operation, the introduction of the alternating-current system of distribution at once made it necessary to provide instruments for its measurement—not only instruments required for metering the current, but also such as are necessary to obtain instantaneous indications of the condition of the circuits carrying the currents. To produce an instrument of small compass and unvarying accuracy that should indicate currents of all ranges of frequency, and at the same time be capable of indicating equally well for continuous currents, naturally involved such conditions that it is not to be wondered at that considerable time has elapsed before such an instrument can be said to have made its appearance. It is true that instruments of this nature, such as the Cardew, have been employed and not without some degree of success, but we think that a close analysis of this form of instrument will show wherein it possesses points of weakness that make it inferior in action to those instruments embodying the electro-dynamometer principle. The instruments of the latter type, as heretofore constructed, have also had their shortcomings, but we believe that on perusal of the description of the new alternating and continuous current voltmeter of Mr. Weston to be found in another column, our readers will admit that the difficulties have been overcome. The degree to which Mr. Weston has succeeded by the light construction adopted in reducing the current required may rightly be considered a triumph of electrical and mechanical skill, and it is not difficult to discern for his new type of instrument a success even greater than that which his magnetic instruments have attained.

THE WIRING OF BUILDINGS.

ONE of the greatest improvements in electric lighting of late years has been the introduction, through the efforts of Mr. E. H. Johnson, of methods of carrying the wires through buildings in conduits or ducts. This plan seems to us correct and proper from every point of view, and we believe the time is near at hand when all interior wires will have to be run through conduits. Laws, ordinances and insurance regulations are all tending to this end, and the rapid extension of incandescent lighting in residences and office buildings has already won over public approval to methods that save the plaster or decorations and that leave the wires accessible. It is this state of affairs that gives importance to the plainspoken discussion of the subject in our columns this week by Mr. Augustus Noll, who was one of the first men in the country to do wiring work, and who is to-day a warm advocate of "piping the wires." It will be seen that Mr. Noll offers some sharp criticisms on devices and apparatus now very popular in the market, and makes some rather surprising statements in support of his claims.

DEALING WITH THE "MUNICIPAL PLANT" CRAZE.

EVERY now and then a town gets the idea that it wants an electric lighting plant of its own. Sometimes the idea is carried out at the expense of the taxpayers, and generally the local company has a hard time of it. An incident that has recently come under our notice shows that, when it will, the local company can protect itself very effectually against these attacks. In a New England city a few followers of Bellamy wanted to adopt municipal lighting, and gained the public ear. The president of the company did all he could to stem the tide of "opinion," but of course he was "prejudiced." He then bethought himself of the papers and articles prepared by Mr. Allen R. Foote and others, showing the true figures of municipal lighting, and had copies sent to 40 or 50 of the citizens. The result was gratifying. To use the language of the president: "We educated the gentlemen in question to such an extent that they made it unanimous. * * * At any rate, some of our National brethren are laid on the shelf for three years." We would recommend a similar line of procedure to others among our electric lighting friends who are passing through this kind of ordeal. The pamphlets cost very little, and can be readily obtained from Mr. Foote and the National Electric Light Association. The results will be very gratifying in any intelligent community.

Underground Rapid Transit.

THE public interest in underground rapid transit for this city was remarkably shown at the dinner of the Commonwealth Club last week, when Mr. Simon Sterne, supported by Mr. Frank J. Sprague and others, made a cogent and forcible exposition of the merits of the Greathead system and of the manner in which heavy electric locomotives had succeeded in London. A large gathering of business and professional men not only heard the arguments with interest but greeted every point with significant applause. Nothing could have been more vigorous than the approval that accompanied Mr. Sprague's statement as to the ability of electric motors to haul the heaviest loads, and his characterization of the criticisms on their assumed inadequacy as puerile and beneath serious consideration. They who know what electric motors are doing will agree with him. The range of the electric motor is greater than that of the steam locomotive, and it certainly does not lose in efficiency as it gains in size.

A New Departure in Telephone Transmitters.

THE recent issue of the Berliner microphone patent, the long-pending application for which has been the occasion of so much curiosity, speculation and criticism, lends peculiar interest to new developments in telephone invention. Mr. Charles Cuttriss's description of his new transmitter, printed elsewhere in this issue, will be found suggestive. A very interesting feature is the absence of electrodes; a characteristic which would seem to differentiate the instrument materially from the usual types.

THE WESTON DIRECT READING ALTERNATING AND CONTINUOUS CURRENT VOLTMETER.

The modern applications of electricity have called for the invention and perfection of many auxiliary devices as safeguards to the circuits carrying the current and also of apparatus for ascertaining the condition of the circuit at all times. Among the latter, the various types of measuring instruments, such as ammeters and voltmeters, have deservedly been the object of much study by many eminent electricians, with the result that the forms which have been devised are only limited by the number of phenomena which may be employed to indicate the presence of an electric current. But apparatus intended for the purpose of affording indications of the condition of electrical circuits, in order to possess value, must be so designed and constructed and embody such principles of action as will permit its indications to be practically constant under all conditions of fair use, and continue so for an indefinite period.

Realizing these important factors, Mr. Edward Weston several years ago invented a type of measuring instrument which embodied in its construction a permanent magnet and a movable coil, which moved in the gap included between the poles of the field magnet and a soft-iron core. This combination formed practically a closed magnetic circuit, which experience has proven to be practically absolutely permanent in its nature. In proof of this we need only cite an experiment which we saw performed and which was as follows: A continuous current voltmeter of the Weston type was attached to a circuit reading 100 volts, and by bringing a magnet in contact with the poles of the magnet of the instrument itself, so that the *N* and *S* poles respectively came in contact, the reading of the instrument was changed from 100 to 22. The magnets were then struck repeated blows with a hammer in order to facilitate any change which might take place in the condition of the magnet of the instrument. The auxiliary magnet was then withdrawn, whereupon the needle resumed its original indication of 100 volts within one-tenth of a division, proving practically that no sensible change had taken place in the condition of the magnet.

The experiment was then tried of increasing the strength of the instrument magnet by placing the *N* pole of the auxiliary magnet in contact with the *N* pole of the instrument magnet, both *S* poles also being in contact. The increase in the field thus brought about served to throw the index off the scale. The shocking of the magnets was then repeated, but, upon withdrawal of the disturbing magnet, the index resumed its first position within less than one-tenth of a division. A more crucial test could not be devised to show the permanency of the magnets employed by Mr. Weston in his well-known type of instrument. Indeed, Mr. Weston goes even so far as to place greater reliance in his instruments than in the tangent galvanometer, owing to the fact that the latter changes its indications with every change in the intensity of the earth's magnetism; whereas his instruments, when standardized, have proved their stability, entirely independent, of course, of all except the most powerful external magnetic influences.

With this success gained in the field of continuous-current instruments, Mr. Weston proposed to himself the problem of constructing an instrument of like accuracy and permanency which could be used equally well on circuits carrying either alternating or continuous currents. Those who have had experience in the measurement of alternating currents, will readily concede that the task undertaken by Mr. Weston was one of no mean proportions, but that, on the contrary, its successful solution might well demand the highest ingenuity, not only in the application of electrical principles, but also in the exercise of mechanical skill, in order to make such an instrument an everday working tool for electricians.

In casting about for the best principle upon which to construct such an instrument, Mr. Weston, after much thought, turned to the application of the principle embodied in the electro-dynamometer, that is, a fixed coil acting on a movable coil; but the mere selection of this principle by no means gave the solution of the problem. It must be evident that in order to be equally applicable to both continuous and alternating currents, the instrument must have practically no self-induction. How to obtain this condition with coils carrying alternating currents may be said to have been the problem solved by Mr. Weston. Starting with the fact that the self-induction of such a system depends primarily upon the strength of the current and the number of turns in the coils, Mr. Weston at once set himself the task of reducing the current required to operate the instrument to the smallest possible amount. The corollary to this was, to construct the instrument so that its moving parts should have the least possible weight, and that the friction should be reduced so as to make the instrument as sensitive as possible. To what degree Mr. Weston has succeeded in fulfilling these conditions will be apparent when we state that the moving coil, pointer, springs and pivots of the new instrument weigh together only 31 grains, that is, less than one-fourteenth of an ounce.

The new instrument is shown in two types in the accompanying engravings, Figs. 1 and 2, which represent, respectively, the double and single scale instruments.

FIG. 1.—WESTON DOUBLE SCALE ALTERNATING AND CONTINUOUS CURRENT VOLTMETER.

The most essential part of the instrument, of course, is the system of fixed and movable coils, the latter being shown enlarged in Fig. 3. The movable coil consists of copper wire .002 inch in diameter, the fineness of which can be judged from the fact that the average human hair is .00225 inch. The diameter of the coil is 1¼ inch, and it is wound so that it presents a ⅛ inch square section, consisting of 525 turns. As the proximity of any considerable quantity of metal near the coils would introduce disturbing factors, it became necessary to avoid the use of a supporting spool for the wire of the movable coil, which upon trial, was found to be quite stiff enough without a spool. The pivots upon which the coil turns are attached to it by means of small aluminum plates, which are first cemented to the coil and then wound with silk thread. The pivots consist of hardened steel, which are ground to gauge and polished. The entire movable system, as stated above, does not exceed 31 grains in weight.

It might be urged that the weight of the coil could have been still further reduced by the employment of aluminum wire, and this, as a matter of course, also suggested itself to Mr. Weston. Indeed his first instruments actually embodied aluminum wire coils, but it was found that aluminum could not be drawn practically below .005 or .006 of an inch, although Mr. Weston himself has, with great care, succeeded in drawing it down to .00325 ; but as a still finer wire was needed in order to meet the requirements of the case, Mr. Weston was obliged to fall back upon copper, aluminum being employed wherever possible in the other parts of the movable system. It will be noted that the coil is balanced practically for all positions, in the same manner as a watch balance, and, as in the magnet type of Mr. Weston's instruments, acts against the force of very delicate springs which also serve to carry the current to and from the coil.

It will also be noticed that the coil is provided at its lower end with a disc which constitutes part of the friction device provided for the purpose of damping the instrument. It will be evident that, as above stated, the placing of any metal near the coils to effect damping would cause injurious reactions. In the same manner magnetic damping was not permissible as it would cause the indications to differ with the rate of frequency of the alternating current ; hence it became necessary to control the instrument by mechanical means in order to bring the parts quickly to rest. The brake in the instrument illustrated is combined with the contact-key shown as the hard rubber knob in Figs. 1 and 2. The brake normally presses against the disc and holds the moving parts rigid. When the key is depressed the current is first turned on and then the friction is gradually reduced just sufficiently to allow the coil to gradually move along until, by the time the key is fully depressed, it has reached the position due to the action of the current and indicates the proper reading on the scale. Thus while the instrument in itself is not dead-beat, the means provided by the brake allow readings to be taken nearly as quickly as with a dead-beat instrument.

The stationary coil which surrounds the movable one just described, consists of wire .003 inch in diameter, the number of turns of which is as small as possible compatible with securing the necessary field of force, the coil being wound on a very thin, hard rubber shell. The amount of current needed to move the index across the entire scale differs somewhat in the various ranges made, varying from .02 to .056 of an ampere in the two-scale instrument, with the lower scale reading to 60 volts and the upper to 120. The resistance of the instruments averages for 60 volts about 1,100 ohms, and for 120 volts about 2,200 ohms.

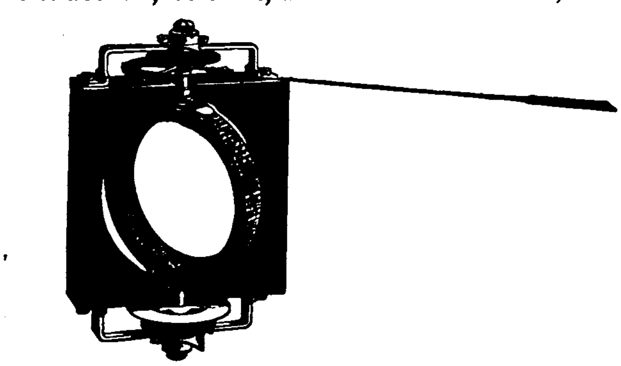


FIG. 3—MOVABLE SYSTEM OF WESTON ALTERNATING AND CONTINUOUS CURRENT VOLTMETER.

In single-scale instruments the resistance is generally much higher and the current lower. The principal resistance is in the form of a non-inductive resistance coil outside of the operative system, which is placed in series with the latter, the movable and fixed coils also being in series.

Not the least important part of the instrument is the means afforded by it, of obtaining correct readings at all ranges of working temperature. It is a common practice of instrument makers to attach to their instruments a table, giving the temperature corrections, based merely on the changes in the resistance of the copper coils in the instruments ; but it by no means follows, as will be presently shown, that such corrections will give accurate results, and, that, indeed, the indications may vary very largely from the truth when so corrected. While it is true that an increase in temperature of 5 degrees F., for instance, increases the resistance of copper by about 1 per cent., a like change of temperature in the magnetic system of an instrument, may cause changes which may be either positive or negative in their nature, according to the type of in-

FIG. 2.—WESTON SINGLE SCALE ALTERNATING AND CONTINUOUS CURRENT VOLTMETER.

strument. In Mr. Weston's magnetic voltmeters the relationship is such that the increased resistance due to increased temperature in the wire, is almost exactly counterbalanced by an increase in the magnetic system, due to elevation of temperature. Consequently the instrument itself compensates almost perfectly for the change in resistance of its coil, due to changes in temperature. The new alternating current instrument has decided the fact that it was impracticable to compensate directly for both of these sources of error; but there is added a thermometer, the bulb of which extends over and comes in contact with the coils and is so flattened and contains such a small amount of mercury so as to give quick response to the slight changes in temperature of the coil. The stem of the thermometer is placed below the glass cover and can be easily read.

The compensation for changes in temperature is provided for by means of a minute rheostat shown at the right-hand corner of the instrument, which has a dial graduated into 20 parts, each indicating a change of 2½ degrees F., and the whole extending between 60 and 100 degrees F. This provides for a change in temperature of 50 degrees, which is sufficient for all practical purposes. To compensate for temperature, therefore, it is only necessary to note the reading on the thermometer and to turn the pointer of the rheostat to the mark corresponding to the temperature indicated by the thermometer. The actual changes in the resistance due to temperature are small, as a large proportion of the resistance is German silver, less than $\frac{1}{10}$ of it being of copper.

A question which many will ask regarding the instrument is, Will the indications vary with currents of different number of alternations? The practical elimination of the effects of self-induction, as described above, is the best answer to this question. Experiment has shown that no difference can be detected in the readings of this instrument between a perfectly continuous current and one varying from that up to 300 alternations per second, a range covering all practical systems of electrical distribution in use at the present time, and proving the instrument to be practically without self-induction.

It is interesting, as showing the marvelous delicacy and accuracy of the instrument, to note that a weight of .4 of a gram, about six grains, acting on the movable system at a radius of half an inch, will cause the index to move entirely across the scale, and, as the instrument is sufficiently sensitive to indicate $\frac{1}{1000}$ of the whole scale, it will indicate to the $\frac{1}{1000}$ part of .4 gramme, that is, .4 of a milligramme, or about $\frac{6}{1000}$ of a grain. Indeed it has been suggested that the instrument might be used as a delicate balance. Of course such a result can only be obtained by the reduction of all the moving parts to the smallest possible mass and by very excellent workmanship. As Mr. Weston correctly argues, lightness is necessary not only for accuracy in an instrument, but its very life is dependent on it, as lightness means reduced friction and wear on the pivots under ordinary use as well as that from shocks to which portable instruments are inevitably subjected. In the type of instrument shown in Fig. 1, it will be noted two scales are provided, the upper reading up to 120 volts and the lower to 60. In this way accurate readings can be obtained over both ranges. Instruments are now made which have a range as low as 20 volts with full-scale deflection, and others requiring 5,000 volts for the full-scale deflection. A large variety of intermediate ranges are also made.

It is almost needless to remark that the instrument is characterized by that beauty of design and fineness of work common to all Mr. Weston's work. No detail seems to have escaped his attention and the whole instrument evidently has had every care and attention given to it, to make it eminently suited for the work to be done. The instrument has been under close examination and test for several years, and as now constructed may be considered standard in type and free from all elements tending to introduce error.

IS ACTINISM A SPECIES OF ELECTROLYSIS?[1]

BY PROF. E. J. HOUSTON.

I DESIRE in the present paper briefly to call attention to another probable source of difference of electric potential, that may still further mask or render difficult of detection the differences of potential existing naturally in growing plants. Before doing this, however, I will briefly review some of the more important causes which produce differences of potential in growing plants. The principal of these are as follows, namely:

(1) Various chemical processes that occur in the cell walls of the growing plant. (2) Molecular movements of liquids throughout the plant, which result in the production of diaphragm currents. These molecular movements may either be those caused during the growth of the plant, or may be caused by the mere bending of the plant by the wind, or other cause external to the plant. (3) Differences of potential developed in plants which would result in currents of the general character of the demarcation currents observed in animals; that is currents due to the chemical action of the various liquid materials exuded at the surfaces of injured or abnormal plant tissue. (4) Differences of potential due to the evaporation of moisture from the surfaces of the leaves, derived either from the rain or dew, or from the evaporation of liquid substances given off from the body of the plant. (5) Differences of potential arising from the electrolytic decomposition of carbonic acid, or the various forms which carbonic acid derivatives assume during assimilation.

The causes above enumerated refer to the differences of potential that have their seat in the structure of the plant itself. Another source of differences of potential is to be found in the differences of electric potential that generally exist between the atmosphere that surrounds the plant and the earth or soil in which it grows. These differences of potential being neutralized in the various parts of the plant itself, would, of course, result in the production of electrical currents.

I desire to call special attention to the fifth head under which I have classed differences of electric potential in plants, viz., those arising from the electrolytic decomposition of the various oxygenated carbon compounds derived mainly, if not entirely, from the carbonic acid of the atmosphere. The decomposition in the leaf under the action of sunlight, and the carbonic acid, or its derivative compounds, probably partakes of the nature of electrolytic decomposition. In this direction I would suggest the following lines of investigation, namely:

(1) To ascertain experimentally whether there exists on the opposite faces of a growing leaf, when exposed to the full action of sunshine, a difference of electric potential resulting from the polarization which always accompanies electrolytic decomposition; and if it be so, what is the nature of such polarization. If such differences of potential actually exist, it would of course follow that the illumined face of such leaves, under polarization, would be mainly electro-negative, since it is at or near this face that the carbon and less highly oxidized carbon compounds appear, while the dark or less illumined face would be electro-positive, since it it is here, for the greater part, that the oxygen is liberated. (2) Whether electrodes suitably connected to the opposite faces of a growing leaf in the presence of sunshine will show the presence of an electric current arising from an equalization of the difference of electric potential. (3) Whether a suitable leaf-battery could not be devised by connecting, in alternate succession, the opposite faces of a series of leaves on a plant-stalk. (4) A comparison of the effects of sunlight and artificial light, such as the electric light, on such electrolytic decompositions. (5) Whether any differences exist in the case of the light produced by an alternating-current arc light and that produced by a constant-current arc light. (6) Supposing the presence of the differences of electric potential due to the electrolytic decomposition to be established, and the direction of the electric currents so produced, known, to ascertain whether an electric current led through the plant in the same direction as the current produced by actinism would not tend to increase the assimilation and the subsequent growth of the plant; and, whether, on the contrary, an electric current sent in the opposite direction through the growing leaf would not tend to check such assimilation of growth. (7) To ascertain experimentally whether the converse of the proposition is true, namely, whether an electric current of approximately the same strength as that produced by actinism, when sent through the leaf in the opposite direction, would not result in the production of luminous phenomena in the leaf.

The following facts, well recognized in botany, would seem to show, to some extent, at least, the presence of a species of polarization in certain plants during active growth in sunshine. In the case of those plants which bend or become concave on the side the most exposed to light: This curvature is due to the fact that a smaller growth occurs on the illumined than on the dark side. This is well recognized in botany, and such plants are called in general *heliotropic* plants.

In the case of plants that turn toward the sun: It is a well-known fact that some plants turn toward the light. It is possible that this motion is in some manner the result of the polarization effected during growth by the sunlight. In a series of experiments concerning the effects of the electric light on plant growth made at the Experimental Station of Agriculture of the Cornell University, some important facts were discovered concerning electric plant-culture.[1] These experiments seem to show that electric light promotes plant assimilation, and sometimes hastens plant growth and therefore maturity.

The Cornell experiments made during 1889 and 1890 were with the light of a constant-current Brush arc lamp. Those made during 1891 were with the light of a Westinghouse alternating current arc lamp. It would seem to be a matter of considerable interest in the case of these experiments to ascertain definitely whether any marked differences exist between the action of the light produced by a steady current and that produced by an alternating current. In the line of investigations here suggested it would of course seem as if the electric decomposition would be less marked in the case of the light produced by an alternating current than that produced by a steady current. And that therefore in those cases where the electric light of the steady current had proved to be injurious to the growth and assimilation of the plants, that with the alternating-current light such injurious effects should be less marked.

MR. GEORGE PORTER has entered upon the duties of secretary of the National Electric Light Association, vice Mr. Beane, resigned. The new secretary has already done good work for the association in bygone years, showing himself unsurpassed as chairman of the transportation committee.

1. Abstract of a paper read before the Electrical Section of the Franklin Institute.

1. See THE ELECTRICAL ENGINEER, Oct. 14, 1891.

THE DISCUSSION OF GOVERNMENT TELEGRAPHS AT THE ELECTRIC CLUB.

THE lecture on the "Government Telegraphs of Europe," by Mr. E. Rosewater, editor of the *Omaha Bee*, printed in THE ELECTRICAL ENGINEER last week, was followed up by a very brisk discussion.

MR. ROSEWATER added the following: Before concluding I want to say that in advocating the transformation of our system of telegraph to the postal system, I have no personal interest whatever beyond that of a citizen of the United States. I have no grievance against any telegraph official. I am on the very best of terms with all the Western Union officials so far as I know, and with the Postal Telegraph officials. I have always been on good terms with them. The paper of which I own the greater part is a member of the Associated Press. We have leased wires and pay the Western Union probably from fifteen to twenty thousand dollars a year for special service; so that I have no grievance whatever, personal or political. I have nothing to redress. But for more than twenty-five years I have been convinced that sooner or later the Government, as a matter of military necessity and as a matter of commercial necessity and in the interest of the social intercourse of the common people of the United States must own the telegraph and operate it; and this conclusion all disinterested parties must reach when they examine impartially the figures and the records that are presented by the reports of the Western Union Telegraph Company and other companies of this country, and the reports that have been made abroad by the different governmental postal telegraph officials. There is no doubt whatever that our wire system is enormously overloaded. We have more wires than we need, and we have them in the wrong place, and we do not serve one-half the people with telegraphic facilities that ought to have them and at a lower price than they now are; and we cannot lower the prices so long as the present system prevails. Competition is always followed by combinations, and one company springs up and declares, like all the newspapers that spring up, that they are here to stay, but in a short time they are swallowed by the great American anaconda. I do not blame the anaconda for swallowing them, but they are not very desirable morsels. As a matter of fact they have congested the anaconda very badly. (Laughter). But it is one of those laws of necessity. Now, how much longer is this to continue? The present telegraphic system of this country is stocked for about $100,000,000—a little more than that. Upon that the people of the United States, the patrons of these telegraphs are paying, independent of the excessive cost of maintaining and operating six million or more dollars as dividends. Now six million dollars on the British basis or upon the basis that we can establish, for our credit is just as good as that of Great Britain, represents a capitalization of $200,000,000, and we could better afford to-day to pay $200,000,000 for the American telegraph systems and place them under the control of the Government, than we can to continue this system and keep on like a snowball, rolling and rolling and enlarging and making it utterly impossible in the future to deal with the problem that must sooner or later meet us again.

I speak specially of the problem of handling telegraph dispatches during time of war. It is all well in time of peace. But those who have been where I was during the Rebellion, realize, perhaps as fully as any one can, that a Government that does not control the arteries of communication and the system which is equivalent to the nervous system of the body cannot possibly sustain itself in time of war without serious disaster and without an enormous increase of expenses and a prolongation of the war costing millions of dollars and many hundreds of thousands of lives. I have said it and I can repeat it to-night that I am fully convinced if the Government of the United States had owned the wires at the outbreak of the Rebellion in 1861, the war would not have lasted more than two years. But I cannot digress in this way now, and I will leave it to other gentlemen, for I would like to have this matter thoroughly discussed. There are two sides to it, as has been said before, and I would be pleased to hear from those who differ with me on this question.

MR. ERASTUS WIMAN, who presided, while complimenting Mr. Rosewater on his address, failed to see much of an argument in it for government telegraphs. He said: "It has always been a matter of surprise to me that those who say that the Government should go into any business should want to have it go into electricity. It seems to me it would be better to go into oil. If the Government wants to do the people good and exercise paternalism over them, oil would be very much more adapted to its purpose. The objection against the present system of telegraphy is that it is a monopoly. It is not nearly the monopoly that oil is. There is a great deal more monopoly to-day in the Standard Oil Company than there is in the Western Union Company. There is only one oil company and there are 40 telegraph companies. A man can go to Wall street and buy a share at about 80 or 83 in the Western Union Company. To save his soul he cannot buy a share in the Standard Oil Company. Any man for $80 can know everything about the Western Union Company—exactly what the officers receive and every other detail. But I defy anybody under the sun, except the syndicate of the Standard Oil Company, to discover the details of the operations of that company. How many per cent. of the people do you suppose are affected by the telegraph? It is a fact that not three per cent. of the population of the United States use the telegraph; while I believe 97 per cent. use oil."

Mr. Wiman then called attention to the shortcomings of various government departments, and drew the inference that telegraphs would fare no better. Moreover, so long as the principle "To the victors, the spoils," prevailed, there would not be any safety in government service during times of great political excitement.

MR. A. R. FOOTE—Mr. Chairman and gentlemen, I think Mr. Rosewater and Mr. Wiman have both lost sight of the fact that whoever operates the telegraph, whether it is a private corporation or the government, people must be employed to do the work. Those people in this country are bound to be politicians. Members of the different political parties have operated the telegraph for a long time but there has never been a complaint from any political party that it was badly treated under the present system. How they will get along under government ownership I do not know.

Mr. Rosewater closed his paper with a statement that it is necessary for the safety of this country that the Government shall own the telegraph. We have supposed that it was necessary for the safety of this country that the Government should own its army. When the civil war broke out in 1861, the men who were loyal handled the telegraph keys loyally. The men who were disloyal did the other thing. We had in our government men whom we had educated at West Point, and one of them became the President of the Southern Confederacy. The Government owned West Point then and owns it yet. If government ownership were a security against disloyalty, there should have been no disloyal men in the Southern army who were educated at West Point. Will Mr. Rosewater say to this audience or to the Association of Old Time Telegraphers, or to the Military Telegraphers' Association that the service was not safe in their hands during the war? Was not that service well and loyally done?

Mr. Rosewater paid a compliment to the operators in America by saying that one American operator does about twice the work that an English operator will do—two to one. My observation of the way clerks work in the city of Washington and the way they work in your private business offices leads me to believe that the clerks employed in private business do twice the work of clerks employed by the Government in Washington—two to one. I do not see in this any reason why the Government should own the telegraph.

I understood Mr. Rosewater to say that the countries in Europe where the government owns the telegraph are as quick to take up inventions and utilize them as they are in this country. I understood him also to say that in three out of the four countries he visited, messages are received by the recording Morse instrument; that the only exception was England were they work by sound.

If Mr. Rosewater stated to the audience how many post offices there are in England and how many telegraph offices there are I did not hear him.

MR. ROSEWATER—If you will allow me to answer you and give me a little time after you have concluded, I will give you all the information you want.

MR. FOOTE—The public are under the impression that a postal telegraph system means a telegraph office at each post office. That is the impression given out. According to the best statistics I can get, such is not the case in England. In England in 1889 there were 17,829 post offices and 7,021 telegraph offices, being one telegraph office for every two and-a-half post offices. In the United States for 1891—these statistics are from the *World* Almanac—there are 66,000 post offices and 25,591 telegraph offices, being one telegraph office to every two and one-twelfth post offices. The percentage of telegraph offices to post offices in this country is a little greater than it is in England.

In England the increase in the number of telegraph offices for two years from 1887 to 1889 was 517. There were 6,514 offices in 1887 and 7,031 in 1889. In the United States the increase in telegraph offices for the same time was 3,116. There were 15,876 offices in 1887 and 18,992 in 1889. The increase for England on 6,514 offices is but 8 per cent., while the increase for the United States on 15,876 offices is about 20 per cent. The increase for the United States, 3,116 offices, on the number of offices in England is nearly 48 per cent. against the English increase of but 8 per cent.

Mr. Rosewater did say that we have too many wires and that the country is doing about one-half the business it ought to do. We may look for an explanation in a comparison of telegraph offices with population and area. In England, taking the census of 1881 and adding 10 per cent. to it, to bring it up to date, there is one telegraph office for every 5,500 population. In the United States there is one telegraph office for every 2,400 population. I wonder why Mr. Rosewater did not stay in England and get the people to extend the benefits of the telegraph so that they might be served in equal proportion to population with the United States.

The size of the country has something to do with the problem.

In England there is one telegraph office to 17.27 square miles. In the United States there is one telegraph office to 131 square miles.

The population to the square mile has something to do with the problem. In England the population is 320 to one square mile. In the United States 17.93 to one square mile.

The area and population to telegraph offices compare as follows:

England, area 17.27 square miles, population 5,526.

United States, area 131 square miles, population 2,349.

A short time ago it became my duty to formulate a schedule for collecting the statistics of telegraph companies for the Eleventh Census of the United States. In a certain report which I called for, the telegraph companies wanted to enter commercial news messages, press messages, etc., I said no; what I want is a report that will show what the farmers and wage-workers of this country are paying for the service you are rendering in comparison with what the same class of people pay for the service rendered them by governments that own and operate the telegraph systems in foreign countries. For this reason I would admit to the report full rate, night-rate and money transfer messages only, and at the rate now being paid over the counter by any one who may have occasion to use the telegraph. I have made up the figures for 8,358 full-rate messages, 614 night-rate messages, and 6 money transfer messages. I find that these messages contained 195,914 words, counting all words in the address, body and signature of the message, making an average of 21.82 words per message. The reason for counting the words in this way is that the governments owning and operating telegraphs count and charge for every word transmitted. The tolls paid for these messages average 41¼ cents each. The English rate would be 21 cents each. On the face of the showing thus far made it appears that the rate in this country is double that of England. I find, however, that the average mileage of these messages was 540 miles, and the average distance from New York to the places to which they were sent is 603 miles. On account of distance the office transmitting 8,978 messages repeated over 11,000 messages in the same period of time. As the greatest distance in England is not over 600 miles it is reasonable to assume that the average mileage of 8,978 messages sent out from London will not exceed one-half the average mileage of the messages sent out from New York. Therefore, messages from New York averaging 540 miles at 41¼ cents each are as cheap as messages from London averaging one-half the distance at 21 cents each. This, however, is not the whole story. These messages were sent at the rate given in any direction desired from New York. England is not large enough to make a comparison with the United States. We are compelled to take Europe for such a purpose. If a citizen of London wishes to send a message five or six hundred miles in any direction it must go into other countries, as the American citizen's message goes, from State to State. Let this be tried and then make a comparison of European rates with United States rates.

Rate from New York on 8,978 messages averaging 21.82 words and 540 miles is 41¼ cents each.

Rate from London for a message of 21.82 words, distance 600 miles:

To Sweden	$1.74.	U. S. rate same distance	41¼c.
" Norway	1.52.	" " " "	41¼c.
" Germany	1.30.	" " " "	41¼c.
" Austria	1.52.	" " " "	41¼c.
" Corsica Isles	.87.	" " " "	41¼c.
" Spain	1.74.	" " " "	41¼c.

I suppose this explains why so many people come to this country. It must be to enjoy the privilege of telegraphing a long distance at the low price charged by our grinding monopolies. (Applause and laughter.)

I do not know whether Mr. Rosewater can be said to be the representative of the Postmaster General or not; but I do know that we can judge of the kind of advice that the Postmaster-General has received on telegraph matters by his official utterances. Here is an official circular dated June 15th, 1891, fixing the rate for Government messages, 10 words exclusive of place from, date, address and signature, at 10 cents to all distances up to 400 miles. As the message actually counts 20 words, this is 10 cents for 20 words for 400 miles. Half a cent a word is allowed for each additional word. I would like to have Mr. Rosewater state, if he will, whether he believes that a charge of one-half a cent a word will pay the expense of doing the business over a distance of 400 miles? On June 29th, 1889, the Postmaster General issued an order fixing the rate at one mill a word irrespective of distance for all messages day and night. If one mill a word for all distances day and night, was a fair and honest compensation in 1889, I would like to know what has increased the cost of telegraph service to bring it up to half a cent a word for 400 miles in 1891?

I am somewhat disappointed that Mr. Rosewater told us so much about the detail of the mechanism of the telegraph and so little of the argument in favor of government ownership. I am not clear from what he has stated whether he meant to advocate government ownership or government control. There is a broad difference between the two. Not knowing what Mr. Rosewater was to say this evening I have brought here a reported interview with him. I do not know whether he will object to my commenting on what is in that interview or not.

Mr. Rosewater—I never heard of the interview. If they have an interview with me; that is all right. I will say that about three weeks ago Miss Kate Field called on me and wanted to have an interview for her paper. I stated that my time was too much occupied in the commission in which we were engaged and advised her to read the testimony that I had given before the Post Office Committee, and said that whatever other matter she wanted she could ask me for. She never came back but she carried off the little pamphlet and copied it *verbatim et literatim* into the paper. If that is the matter, why it is a very stale piece of news.

Mr. Foote—I suppose it is correct?

Mr. Rosewater—Oh, it is correct. If it is what I testified before the committee.

Mr Foote—That is the main point. We do not care how old it is if it is true. Truth never dies.

There is one point in this Kate Field article to which I wish to refer and Mr. Rosewater can easily set himself right if he is wrongly reported. He says here: "I would buy out all the telegraph lines in America and then advertise for proposals and have them operated by private companies under the control of the Government, fixing the rates and requiring them to report their earnings from time to time to the Government. When the receipts exceeded 10 per cent. upon the invested capital, their investment being rather small, I should insist upon their reducing the rate." I suppose he means dividends instead of receipts. To give an idea of what Mr. Rosewater considers a small capital, he is reported here as saying that when the Government turned over the military lines to private companies, Feb. 27, 1866, it owned 41,211 miles of land line and 178 miles of submarine cable. I understand that to mean miles of wire instead of miles of line. He is reported to have said that the property was worth $2,000,000 to $3,000,000. Was it miles of line or miles of wire?

Mr. Rosewater—I presume it is miles of wire.

Mr. Foote—Assuming that Mr. Rosewater means miles of wire and that he will probably agree that the true valuation would be the average between his extremes, the statement may be construed to mean that the Government owned 14,389 miles of wire worth $2,500,000 or about $174 per mile. At this rate the present valuation of the combined mileage of the Western Union and Postal Telegraph Companies is $138,332,834. Now if the military telegraph lines were worth $174 a mile it is fair to presume that the lines that are now working commercially are worth as much. The capitalization of these companies, however, does not begin to reach the value given by Mr. Rosewater. This may be where the watered stock is to come in. I am of the opinion that if Mr. Rosewater can induce the Government so to fix rates that the companies can earn 10 per cent. on this valuation that they will give him an exclusive contract to attend to their stock-watering hereafter. Government ownership is advocated by Mr. Rosewater as a principle. In my opinion the principle is radically wrong. It is opposed, as I understand the matter, to the underlying fundamental natural laws that govern all human actions. When you separate a man from any direct interest in his work or any hope of having any direct interest in his work, you separate that man from the most active elements that can induce him to be thrifty, saving, progressive, observing and careful in every thing he does. I do not suppose that any of you gentlemen will admit for one moment that there has ever been a work undertaken by government that has been executed at anything like the cost it could have been by private parties. A gentleman with whom I was conversing in Boston not long ago—a very competent engineer—observing the work on Government buildings, forts and arsenals, etc., said that he did not believe that, with two or three exceptions, in these United States there had been one single instance where a Government building had been put up at any thing like the cost it would have been erected by private parties. He estimated that the excess of cost was at least 100 per cent. In other words that it cost the Government twice as much to do the work as it would private parties. Assuming for the sake of the argument that the capitalization of these telegraph companies can be agreed upon; they have accepted a law passed by Congress in 1866 which defines the way in which the Government can acquire possession of their property. If the capitalization is agreed upon and the interest on the capital is fixed at the same rate that the Government pays on its bonds the capital question will be out of the way. Then comes the question of maintenance and operating expenses. I do not think that any one will suppose for an instant that such expenses, operating under government ownership in this country would come anywhere within the limits that they do under private management. I do not think that 20 per cent. difference would be too large a margin to allow for the difference in effective management. Therefore, I assume that the telegraphs of this country, operated under private management, doing a business at the same rate that it would cost the Government to do the business could pay at least a 10 per cent. dividend and at the same time be furnishing the service at what the ordinary politician calls cost—which is what it would cost the Government.

The absence of statistics for all these details is the weak point in the argument. When we do not have statistics which both sides can agree upon as being true and accurate we cannot follow our arguments to their legitimate conclusions. I have under my hands the work of obtaining these statistics from the telegraph companies in the United States. That work will be accomplished in the course of time provided the Government will furnish the funds to do the work. It is now practically at a standstill. Those of you who want to have the statistics will have to assist in getting the appropriation. (Applause).

PRESIDENT INSULL thought that Mr. Wiman must be drawing his political conclusions from Canadian experience. As to the work in England, he would draw attention to the fact that the government authorities there had put their telegraph wires underground while the American companies were saying that it could not be done. Moreover, the high rates that prevailed in this country were not such as to help in building up new sections, such as the Northwest, where a pioneer would be taxed not 12 cents for 12 words, but 13 cents for a single word. "The great advantage of the government administration of telegraphs more especially in England, where I have had some experience, is that if you are in the smallest village where there is transmitted but one message a day, you pay exactly the same rate as you would in a larger city, and the business man there has the same opportunity to develop his business that the man has who lives in a large centre of population." Mr. Insull pointed out that Mr. Foote's figures as to the number of American offices overlooked the fact that many of the offices he counted were useless and unnecessary duplicates, provided by competing systems. He had no very decided views on the subject, but saw no reason that the same control could not be exercised over the telegraphs that was exercised over the railroads. Such control would undoubtedly inure to the advantage of those who sent telegrams. As to the difference in speed of operating, Mr. Insull thought that atmospheric conditions had a good deal to do with the lower efficiency in England and Europe.

MR. ROSEWATER.—I happen to have with me a few figures that I made up to-day from the official book in the German language, by the Austrian Government, giving a full account of all European postal facilities and telegraphic facilities, and I find this to be the fact that in Great Britain the number of post offices by the last report of the Postmaster General was 18,359, the number of telegraph stations 7,627. That is for the year 1890. I have a report with estimates for 1892.

MR. INSULL—Would not those figures include the stations they have for the reception of packages?

MR. ROSEWATER—I want to show you the reason why they do not have so many telegraph stations; inasmuch as they receive telegrams at all post offices, they do not require so many telegraph stations. They have only 5,912 postal telegraph offices and 1,715 railroad telegraph offices in Great Britain. France is the only country in Europe probably, and perhaps in the world, that has more telegraph offices than post offices. She has 7,026 post offices, and 9,498 telegraph offices, of which 6,086 are postal and 3,412 are railroad. Austria has 18,017 post offices and 10,806 telegraph offices, of which 5,311 are postal and 5,495 are railroad. Germany has the largest postal telegraph system in Europe; she has 21,212 post offices and 16,408 telegraph offices, of which 12,431 are postal and 3,977 railroad. Now computing the whole thing what do we see? In all these four great countries the total number of post offices is 64,614 and the number of telegraph stations 44,339. You notice that there are nearly two-thirds as many telegraph stations as post offices, and notwithstanding Mr. Foote's statistics I would venture to say that he is entirely mistaken, unless Dr. Green gave wrong figures to the Government last winter. According to Dr. Green there are eighteen thousand some six hundred telegraph stations in America, including all the railroad offices, and to the best of my knowledge the number of post offices is about 60,000 or 61,000. Now we have over sixty thousand post offices and only 18,600 and some odd telegraph offices, and of these you find that the telegraph companies have got less than 5,000. All the telegraph companies have got less than 5,000 telegraph offices and the balance are all railroad offices. Now just compare those countries and see what an absurdity. This is a striking argument it seems to me in favor of postal telegraphy because it enables the people in the smaller towns and villages to get the facilities of the telegraph, and while my friend here says that there are only a few clodhoppers out in the West that are entirely cut-off, it seems to me that every citizen of the United States is as good as every other citizen and it doesn't matter whether he is on a farm or in a work-shop. The object of the postal system is to facilitate the intercommunication of intelligence. If that had been established, no matter what disparaging statements have been made here to day as regards the mismanagement of different branches of governments, I defy any man here to come forward and show where there is a better system under corporate control than the post office system of the United States to-day. (Applause). I defy—

MR. S. BRYAN—I accept that challenge with very great pleasure.

MR. ROSEWATER added that if the telegraphs were turned over to the Government, all the good men would be better employed and better paid than they were before, and that they certainly would not lose their personal integrity and rectitude. As to the value of the telegraph lines turned over to the Western Union Company at the end of the war, he would say that his figure of $2,000,000 was made for a period when gold was worth 180 cents, and everything was in proportion. That peculiar transaction was still unexplained. There were 44,000 miles of wire and 160 or 200 miles of cable, and it was all turned over for nothing. With regard to Mr. Foote's figures of distances in America and Europe, he would point out that right in New York the Western Union Co. charged $1 for a message, and even then would not allow the steamship company to make a bulletin of the intelligence. As a matter of fact the people of the United States had paid the Western Union $250,000,000 since the war, and had that money been paid to the Government they would have a better and cheaper system. As to safety of messages, he believed they would be much securer with a national service than they now are in private hands. All these imaginary dangers were bugbears, and moreover it was not true that government telegraphs did not pay. In England last year, the telegraphs earned a very fair dividend in spite of many heavy charges assessed on them and many expensive additions and improvements. It was certain that England would never return to private telegraphs. Prof. James Bryce, who wrote the *American Commonwealth*, had told him it was absurd and impossible.

MR. BRYAN, who was once connected with the postal service in this country and prominently engaged in developing the postal system of Japan, attacked postal administration very strongly, and drew the inference from its badness that government telegraph administration would be as bad. He spoke also of his personal experience with the telegraph in England and on the Continent, and considered the service very inferior to the American.

MR. E. A. LESLIE, as an old personal friend of Mr. Rosewater in the days when they both were operators, said that the great idea of the lecturer was to promote the welfare of the operator and that was the noble thought underlying all his arguments on the subject.

College Notes.

A FOUR YEARS' COURSE IN ELECTRICAL ENGINEERING AT COLUMBIA COLLEGE.

AN undergraduate course of four years in electrical engineering has been established in the School of Mines, Columbia College, in addition to the present two-year post-graduate course which has been in successful operation for several years. Thus there will be two complete courses in electrical engineering in New York City. The latter course is for graduates of scientific schools and colleges and is entirely devoted to electrical engineering proper, the students having already passed the necessary preparatory studies in mathematics, physics, chemistry, mechanics, drawing, etc. This course is found to give the most excellent results by reason of the maturer years and better training of post-graduate students.

In addition to such graduate students there are, of course, a much greater number of younger men who desire to enter a course of electrical engineering immediately on leaving school without going through a previous collegiate course. A new four-year course has therefore been established parallel to the well-known courses in mining engineering, civil engineering, chemistry, architecture, etc., at the School of Mines, with the same requirements for admission, which are equal to the regular entrance examinations at first-class scientific schools. The first two years of the new course will cover the preparatory work in mathematics, physics, chemistry, mechanics, drawing, etc., required for admission to the post-graduate course. The last two years will be devoted to a thorough course in electrical engineering proper and will be equivalent to the present post-graduate course, hence there will be no lowering of standard.

As a preparation for the study of electrical engineering the first two years of this course are equivalent to four years in any course other than electrical engineering, thereby saving much time without sacrificing any electrical engineering subjects.

The instruction in electrical engineering will be conducted as heretofore by Prof. Crocker and Dr. Pupin. The mathematics, physics, etc., will be taught by the respective professors of those subjects.

The degree given to those who satisfactorily complete the course will be that of electrical engineer. The new course will regularly begin October, 1892. Examinations for entrance are held June and September. The one-year partial, or special course, will be abolished next year to make room for the students in the regular courses.

SAFETY DEVICES.[1]

BY C. C. HASKINS.

VARIOUS metals having different electrical carrying capacity, must necessarily be variously affected thermally; and as some of these fuse at a much lower temperature than others it is readily seen that protection from abnormal heat in an electrical conductor is readily arrived at by the use of the fusible strip, which, placed in direct line with the passing current, will, before undue heating of the conductor proper takes place, melt, and thus break the continuity of the conductor.

Such, briefly stated, is the usual method of protection from abnormal currents. Let us look at this subject for a brief time, and see if in practice this is as reliable as theory would indicate.

The material from which these devices are constructed may be either a simple metal or an alloy of two or more metals in combination. A curious fact in this connection is that an alloy may be made of two metals which has a lower melting point than either of the metals of which it is made.

The metals which are more commonly used are tin, bismuth and lead.

The melting point of tin is	451°, F.
" " " of bismuth is	512°, F.
" " " of lead is	620°, F.

Now, different combinations of these metals will give us widely different results. Equal parts of tin which fuses at 451° and lead, which fuses at 620°, will give us an alloy which will fuse at 385°. Tin and bismuth in similar proportions will fuse at 250°. One of tin, one of lead and four of bismuth will melt at 200°. Lead 5, tin 8 and bismuth 8 form a combination which melts at 212°. Other combinations will give us an upward range far above the necessities of the case, and the admixture of other metals will give any desired melting point.

W. H. Preece has furnished us with the results of a long list of experiments, in his fuse table. This table gives the sizes of pure wire which will fuse by a current of from 1 to 5 amperes up to 50, by steps of 10 amperes to 100, and by steps of 20 amperes to 200 amperes. These figures are given for tin, lead, copper and iron.

In the matter of safe carrying capacity of copper wire there seems to be considerable diversity of opinion. We are told that a No. 0000 wire B. & S. gauge is good for 312 amperes by one authority, a second says 229 amperes, while a third says 300 amperes, and the last speaker says 175 amperes. Number 6 is given 65.2, 43, 80 and 35 amperes. Number 14 is given 16.2, 11, 22 and 10. These various figures come now from the Board of Trade of England, from Boston, from New York and from Montreal. With such a broad field for selection it would certainly seem possible that a perfectly reliable fuse should be readily accomplished for any known requirement, and yet with such a disagreement of authorities as given above it is not very strange if the fuse manufacturer should occasionally err in the capacity of the wares he offers.

Mr. Lee L. Summers, assistant electrician of the Western Union Telegraph Company at Chicago, has very kindly furnished me from his note-book some facts which are interesting in this connection. Called to devise some means of protection for conductors carrying small currents, such as are used for telegraphy, his experiments with alloys of tin and lead were mostly confined to those of quite small capacity. He says in substance, the smallest fuse placed upon the market was variously stated by different makers. One claimed them to be of one-half, others of one, and still others of one and one-half to two amperes' capacity. These fuses were either lead alone, or lead and tin. As a rule the lead fused at a lower temperature than the alloy. The exact gauge of these fuses was difficult to ascertain because of their irregular diameter, and the softness of the metal. This lot was samples of so-called one-lamp wire. It melted with between 2¼ and 3 amperes. Attempts were made to reduce the cross-section of these samples, but its feeble tensile strength prevented, for the wire became quite brittle when drawn through the die. His experiments led him to believe that the fuse wire known as of one-light capacity would require an average of about 2¼ amperes to rupture the circuit. German silver was tried by Mr. Summers, the wire being drawn down to 36 and 38 B. & S. gauge. This wire fused with from ¾ to 1 ampere and proved quite constant. But the fineness and delicacy of wire of that diameter unfitted it for general use.

Other parties besides Mr. Summers have given this matter much thought and time, and some of the results are even more remarkable. Among these are the recorded experiments of one investigator with a lot of fuses marked 15, which stood up nobly until melted by 30 amperes. This mark 15 may have meant 15 lamps, but it is charitable to believe it should read amperes.

Not only is the moderately expert electrician allowed abundant choice in the selection and dimensions of his so-called safety strips, but the deplorably ignorant operator can, and sometimes does, impose upon himself, even to the substitution of 97 per cent. copper in place of fusible metal, as he says "because they last better," rather than remove the difficulty which renders the better conductor necessary.

In close proximity to the safety strip matter is another to which I call your attention because of the possible danger which may at any time be drawn from its lurking place through the ignorance of the general public of electrical laws. The electric motor switch, as often constructed, has now and then the uncomfortable habit of stopping at an intermediate point between off and on, thus leaving a portion of the resistance in circuit, and of course a part of the current flowing through it. This current may or may not be sufficient to move the machine, and the switch may be left in that position intentionally or accidentally. When the quitting time arrives there are few employees in many an establishment who are not ready to rush for the door. It is very easy to stop a machine by throwing the switch lever part way over in the haste of quitting time, and had we nothing better than theory to base the statement upon, it might be hard to prove that such an act of carelessness was ever committed.

Let me give you two dissimilar cases which I assure you are authentic. A fan in a restaurant was run by a motor, and doing excellent work during extremely hot weather. The weather changed suddenly and the economical proprietor thought to save some current, and run his motor slower by turning in part of the rheostat. He knew just enough of electricity for that, and his little learning proved a dangerous thing. You have anticipated the result. It didn't melt out the safety plug, but it heated the fire department and warmed the underwriters. In another case a small motor was used to run a light piece of experimental machinery, in a dark corner of one of Chicago's sky-scraper buildings. It required all the current to run the fake, whatever it was, and when the schemer left the room at night he turned the switch just far enough to stop the motor, locked up and went home. The department extinguished the blaze about two o'clock the next morning, and the fuse was not injured.

Now mark, these two cases show that under some circumstances the best of soft strips may be thoroughly valueless.

This state of things has existed, and does exist to some extent to-day, and yet the remedy for this class of danger seems to me simple and easy of accomplishment. If the stationary motor switch is so made that it can never be left between full on and full off, it can never be so left.

But the soft strip conundrum is not so readily answered. There are several points to be considered.

1. When the ordinary dynamo man requires a wire or strip of a certain capacity he must perforce take on trust the article given him. He has no means of verifying the purchased article, and may, or may not get what he requires. And more than that. High authority has advised that all soft strips should be made of sufficient carrying capacity to allow a surplus of 25, 50, or even a larger per cent. excess over the marked capacity. As in many instances there is no mark on the fuse it is not beyond the range of possibilities that the salesman may err in supplying the purchaser, or that the latter may mistake in replacing a fuse.

2. The fuse wire may change its carrying capacity by exposure. Oxidation has that effect. If it is firmly fixed when first placed, unless it has a hard metal terminal the constant pressure tends to flatten the contact, and thus loosen the connection—possibly setting up an arc at that point. The constant vibration of a building tends to loosen any but the most firmly set screws, so that here are two evils to be avoided.

3. There is no means at hand for effectually preventing the user from endangering not only his own, but his neighbor's property, by substituting other than fusible metal in the cut-outs.

For these several difficulties there should, it seems to me, be found reasonable and simple remedies It was once customary to designate the limit permitted upon a wire by the number of lamps. This is no longer practical. There is such a variety of lamps, so many different voltages, and hence so many differing rates of current absorption, that our only standard of allowance is the ampere. It seems to me that the device, whatever shape it may assume, should be so arranged that its actual capacity at a certain temperature can be known at a glance. The cut-out block should be so construced that only the strip for which it is marked can be used with it. A 10 ampere block should not be made capable of holding a 20 or 40 ampere strip. With a given alloy the manufacturer would be able to make his strips uniform, so that the carrying capacity would be easily verified by a wire gauge or micrometer. So many millimetres wide, so many thick—so many amperes capacity, and no more.

I make these suggestions as a possible solution of a difficulty which is growing formidable, and in the hope that by drawing attention to the existing necessity, the matter may be thoroughly sifted and proper remedies applied.

DISCUSSION.

MR. FORÉE BAIN drew attention to experiments made by him which proved that the rupture of fuses is dependent largely upon the suddenness with which the current is applied, a 10-ampere fuse

1. Abstract of a paper read before the Chicago Electric Club, December 7th, 1891.

carrying 42 amperes with a gradual application, while a sudden rush of 10 amperes ruptured it. To remedy this he suggested the employment of a spring or weight which acts to agitate and stretch the metal when the temperature rises; this reduces the cross-section and augments the effect of the overload, even though it comes on gradually. Mr. Bain also preferred a pure metal, such as tin to an alloy, the slightest difference in the composition of which makes a large difference in its character. Tin has a lower melting point than any other pure cheap metal, except lead; does not oxidize so readily, and does not crush like alloys. Mr. Bain also described a battery cut-out embodying a thermostat operated by the heat generated in a fine German silver coil. He was not in favor of electromagnetic cut-outs as they offered mechanical resistance and they did not afford good electrical contacts especially when used for heavy currents.

Legal Notes.

INCANDESCENT LAMP LITIGATION—THE UNITED STATES ELECTRIC LIGHTING CO. vs. THE EDISON LAMP CO.

THE action brought in the spring of 1889 by the United States Electric Lighting Company against the Edison Lamp Company, in the United States Circuit for the district of New Jersey, alleging in fringement of a patent granted to it in 1884, as assignee of Edward Weston, for an improved process of manufacturing conductors for incandescent lamps, came up for final hearing in Philadelphia, on December 9th, before Hon. Marcus W. Acheson, circuit judge; Hon. Edward T. Green, who was also to have participated in the hearing of the case being indisposed and unable to sit. Kerr & Curtis, solicitors for the complainant company were represented by Thomas B. Kerr of New York and George H. Christy of Pittsburgh, of counsel. Eaton & Lewis, solicitors for the defendant were represented by Sherburne B. Eaton and Frederic H. Betts of New York, of counsel. The opening argument in behalf of the complainant was begun at 10 o'clock by Thomas B. Kerr.

ARGUMENT OF MR. KERR FOR THE UNITED STATES COMPANY.

Mr. Kerr said that the bill in this case was filed by the complainant as assignee of Edward Weston, for the infringement of Letters Patent No. 306,980, granted October 21, 1884 for a process of manufacturing conductors for incandescent electric lamps. He said that this is the case which showed a strong equity on the part of the complainant. The invention was one of peculiar and striking novelty as well as utility in its relation to the electric lighting industries. The light of the incandescent lamp was produced by the resistance of the conductor in the lamp to the passage of the current, the lamp conductor being of a material of less conducting capacity than the wires which convey the currents to and from the lamp. The illuminating conductor must have the capacity of withstanding the intense heat thus produced, through the more or less protracted periods, and the more or less frequent occasions when a lamp is required in the ordinary uses of daily life. Ordinary carbon was early recognized by experimenters as a material possessing certain properties peculiarly adapting it for this purpose, but at the same time combining other characteristics which put its valuable properties beyond reach. One of these impediments was the affinity of oxygen for carbon; when oxygen was present it attacked the carbon as soon as brought to incandescence, and destroyed the conductor; hence experimenters had sought to make a lamp in which oxygen would be excluded from contact with the carbon, and for this purpose they had tried filling the lamp-chamber with a preservative atmosphere, such as nitrogen, and they had also tried to exhaust the air from the chamber. Earnest and unremitting efforts had been made to overcome all these difficulties, but it was not until the latter part of 1880 that they had resulted in the production of a commercial lamp. Another impediment had been the lack of homogeneity in the structure of the carbon. This characteristic produced unequal heating, the weak or defective places offering the most resistance and producing the greatest heat. The result had been that the conductor had soon broken down at these points and the lamp had been destroyed. The solution of the problem of making the resistance of an incandescent carbon conductor uniform throughout its length was of vital commercial importance, for if all other difficulties were removed but this, upon this alone depended the production of a durable incandescent lamp, The problem had been attacked in different ways by different inventors but it had remained to Weston to solve it by the discovery and application of a scientfiic law of singular beauty and of striking utility.

Weston's discovery was that if an electric current be passed through a carbon conductor so as to heat it to a visible heat while immersed in a hydrocarbon liquid or surrounded by a hydrocarbon vapor, the heat would decompose the adjacent hydrocarbon, and would cause the particles of carbon dissociated therefrom to be deposited within the pores and upon the heated surface of the conductor; he had found that the deposit would be greatest at the point of greatest heat, and proportionately less at other places, so that if the operation was continued long enough, the resistance and consequently the conducting power of the carbon would become absolutely uniform throughout its length. By this process the mechanical strength and elasticity of the conductor were at the same time increased, and it also became possible, by the same means, to bring the conductor to any desired standard of resistance so that all the carbons for a particular type of lamp could be made of absolutely uniform conducting power, and capable of rendering a uniform and definite illuminating service.

Mr. Kerr then read passages from the specification of the patent in which these advantages were pointed out, and also from the testimony of Mr. F. L. Pope, the complainants' expert, in which the matter was further elaborated.

The claim of the patent was as follows:

"The improvement in the art of making carbon conductors for incandescent lamps, which consists in first forming a carbon core or base, and then building up said core with carbon obtained and deposited upon the same, by and during the operation of electrically heating said core while surrounded by, or saturated with, a carbonaceous substances, substantially as hereinbefore set forth."

He thought it superfluous to discuss this claim. It was clear, concise and comprehensive, exactly describing and broadly covering the invention. That invention if novel, was of a character which left no question as to its patentable qualities. The very defect of the carbon was made the means of its cure. The relation between current resistance, heat and deposition was sympathetically responsive and exact. It was an automatic process; a law of nature working untrammelled and unimpeded to its natural and perfect end. Human agency set the apparatus in operation and nature brought out the results as certainly as it caused a weight to fall to the ground or water to expand with cold.

The defendant in its answer had denied that it had ever infringed at all, or in any way, the Letters Patent or any rights of the complainant thereunder, but the testimony of the witnesses Whitehead, Clifton, Latus, Marshal and Clarke, was to the effect that the defendant company had treated at least 20,000 carbons in accordance with the invention, for use in the manufacture of incandescent lamps. These men were employees of the defendant company and their testimony was wholly uncontradicted. It was not alleged that Mr. Edison was personally responsible for the infringement, but he would show that the Edison Lamp Company did resort to this process and did make use of it.

He would next consider the defenses relied upon. First, as to Sawyer and Man, it was contended by defendant that Weston had surreptitiously and unjustly obtained a patent for that which was in fact first invented by Sawyer and Man, who were using reasonable diligence in adapting and perfecting the same. The same parties were alleged to have had the invention in public use for more than two years before the application of Weston. This defense of prior invention had already been adjudicated by the Patent Office in Weston's favor. He had filed his application for this patent on May 27, 1881. It had been put into interference Oct. 1, 1881, with the patent of Sawyer and Man of January 7, 1879 (No. 211,262). The issue was that of priority of invention. Both parties had taken testimony in regard to their respective dates, their efforts in reducing to practice and other points pertinent to the issue. That interference record had been stipulated into the present case. Mr. Kerr then read from the the testimony in the interference proceedings showing that Weston had made use of the process he had afterwards patented in preparing carbons, in 1876 and 1877, and had employed these carbons to produce electric light by incandescence. In connection with his testimony Weston had produced certain exhibits, among which were a piece of apparatus used by him in 1876 and 1877, in treating carbons; a sketch of his first apparatus in which the carbon was treated in oil, and of his second apparatus in which the carbon was treated in gas. Several other exhibits of pieces of apparatus had also been put in. These exhibits, although somewhat crude in character, as was usual with the early embodiments of nearly all valuable inventions, were practical and effective in operation, and tended strongly to corroborate the testimony of the independent witnesses as to the experiments which had been made by Weston in 1877 and 1878. Mr. Quimby a well-known solicitor of patents and expert had testified that he first became acquainted with Weston in the spring of 1877; that Weston showed him the operation of treating a carbon by the process of the patent within six months from the date of his first acquaintance with him. Broadbent, foreman of the machine room of the Weston Dynamo Electric Company, testified to having seen Weston treating carbons by placing them in a globe filled with oil and running a current of electricity through them. Havell, although a business man having no special interest in the subject of electricity and called as an adverse witness, yet corroborates Weston in several important particulars. Theberath, another adverse witness was an ordinary workman, whose testimony was wholly negative and worthless. He merely says he was employed by Weston; that he was often in his laboratory, but that he does not recollect seeing him make any experiments in incandescent lamps either in the laboratory or in the shop. His testimony had been contradicted in several important particulars and had been shown to be wholly untrustworthy. Mr. Kerr then proceeded to consider the adjudications in the interference case in the Patent Office, which was decided in favor of Weston by the Examiner of Interferences; by the Board of Examiners-in-Chief, and by the Commissioner of Patents; the three tribunals concurring in the finding. The Commissioner held:

"It suffices to say that after a careful consideration of the evidence I am convinced that Weston made and completed the invention, in a legal sense, prior to Sawyer and Man, and the decisions of the legal Examiner of Interferences and the Examiner-in-Chief that the former is the prior inventor is approved and affirmed."

No new testimony had been brought on the subject of priority of invention, and he would therefore respectfully submit that the concurrent decisions of the three tribunals of the Patent Office in favor of Weston, if not *res adjudicata*, were at least entitled to great respect, and should not be overruled by the Court in the absence of controlling evidence to the contrary.

Referring next to the testimony of Weston that no commercially incandescent lamp had been made until the latter part of 1880, Mr. Kerr read from the testimony of Hebard, from which it appeared that the complainant was at work on incandescent lamps in 1880, first in Bridgeport and afterwards in New York: that in the spring of 1881 complainant having secured all the stock of the Weston Electric Light Company took possession of its factory in Newark; that Weston was made electrician of the complainant company, and that the manufacture of lamps using his hydrocarbon process, became a commercial enterprise during the late spring or summer of 1881. It also appeared that prior to Hebard's official connection with the complainant, it was the owner of patents of Maxim, several of which were for improvements upon the Weston process, but as they contained no claim for the fundamental invention, there was no conflict between them and the patent in suit. It was not until the latter part of 1880 that the incandescent lamp reached a condition of practical utility, so that Weston could adapt his invention to public use, and consequently he could not before that time have made a contract with the public for the 17 years' beneficial use of the invention, which the law provided as a reward to the meritorious inventor. Within a short time after the lamp was perfected Weston had filed his application and in due course had obtained his patent. Hebard had testified that since September, 1890 he had been an officer of the Sawyer-Man Company, and had had the general management of its business. The production had been, a large part of the time, as many as 10,000 or 12,000 lamps per day, all having carbons which had been subjected to the hydrocarbon treatment.

The defendant had produced three witnesses, Hubel, Beers and Bradley, who had testified that they had worked for Weston at various periods between 1876 and 1880; that they never saw him experimenting with lamps or treating carbons, and that they thought if such operations had been performed they were in a position to know it. Such testimony was purely negative in character, and could have but little weight in the face of the positive testimony of witnesses who say that they have actual knowledge of such events. He knew of no case where evidence of this character had been successfully cited against a patent. There were, however, many cases, in which the doctrine had been laid down that such evidence could not be received to overcome the positive testimony of witnesses having actual knowledge of the facts.

Coming now to the allegation of the insufficiency of Weston's specification, Mr. Kerr said that the specification had been criticised by defendant's expert, Clarke, as erroneous and defective, and as embodying information not possessed by Weston or others in 1877 and 1878. Mr. Clarke had testified that he had had an extensive experience in reference to the manufacture of incandescent lamps in connection with Mr. Edison, and with the defendant company, which, however, did not qualify him as an expert in reference to the particular subject matter of the patent in suit. It appeared from Mr. Edison's affidavit and otherwise that defendant companies did not use the hydrocarbon treatment process in its general manufacture, the reason, as stated by Mr. Edison, being that he did not resort to the hydrocarbon process because it was patented in this country and he did not steal patents. Clarke himself says he has had no practical experience in treating carbon conductors except as to certain experiments made in connection with this case. His statements are therefore to be received with allowance. He had been asked as to whether, in his opinion, the information acquired by the witnesses Quimby and Broadbent in the years 1877 and 1878 was sufficient to enable a person skilled in the art to practice the invention. Neither the statute nor the rules of evidence required that the deposition of a witness as to facts within his knowledge, under an issue of priority, should be in the nature of a patent specification.

Mr. Vandergrift, who had been engaged in the manufacture of incandescent lamps ever since January, 1880, when he had first been employed by Maxim, at Bridgeport, and who from 1885 to 1889 had been superintendent of the lamp factory of the complainant company, tried several experiments with the apparatus shown in his sketch, a reproduction of that testified to by Weston, and had shown many of Clarke's statements to be erroneous. Clarke had admitted that the apparatus described in the patent was the same as that which had been used by Weston in his experiments. Vandergrift's testimony had shown that Weston's specification complied fully with the law, and in the best possible way. Indeed the specification went beyond the ordinary requirements of the law, which assumed the specification to be addressed to a person skilled in the art. Any laborer employed about the establishment, by simply making the physical structure described, would inevitably produce the result. Nothing was left to judgment, to skill, or to science; it was only necessary to follow the plain directions of the specification. The invention was not limited to the use of any particular form of hydrocarbon; it might be oil, it might be gas; but it must contain carbon as a constituent element. The evidence is that defendant used kerosene oil; Weston commenced with kerosene and went on to gas, finding that the less the specific gravity of the hydrocarbon used, the finer the result. The only condition was that carbon must be a constituent.

The defendant had taken the ground that the grant to Weston had been barred by two years' public use. Mr. Broadnax had instituted proceedings after the grant; he wanted the Commissioner of Patents to have the goodness to tell him why Weston's patent had been issued. They had his statement that one main object of the testimony taken in the interference proceedings had been to prove prior public use. Mr. Kerr said he had called attention to this, because it appeared to be one of the main defences in the case. There had been a constant effort to make a public use appear, which upon careful scrutiny did not appear at all.

The cross-examination of Weston showed the diligent efforts which he had made to secure an incandescent lamp. There was the long story of his troubles in obtaining a vacuum; his experiments with chemicals, and so on, but though he worked persistently in 1878, '79, '80, no incandescent lamp had been produced until the fall of 1880. All that time Weston had been trying to utilize carbon, but there was no place he could use it, and no way in which he could make it useful to the public. The testimony in this case is uncontradicted, that in the latter part of 1880, the complainant company first succeeded in bringing before the public a commercially successful incandescent lamp. If any question should arise as to whether Weston had been showing due diligence, they should look at his cross-examination. He would ask his Honor to read the whole 40 pages; not a line could be left out. Weston's statement is corroborated by the evidence of Quimby. Quimby's deposition in fact might almost serve as a specification; he had witnessed the operation with an intelligent mind; he had seen this operation of "building up the carbon" going on under his very eyes. Havell, a witness called by Sawyer and Man, had confirmed Weston as to the treating of carbons in oil. These witnesses had clearly established the fact that in 1877 Weston had been treating carbons for the purposes of this invention. He had been experimenting in incandescent lamps. It had been conclusively proven that in 1877 he had had this invention.

The testimony of Sawyer and Man, shows that on March 8, 1878, they first treated carbon for incandescent lamps by the dydrocarbon process. They had made a great many lamps of the pattern illustrated in the *Scientific American;* Man says, hundreds of them. But the evidence was, that though the lamps were tried, *not one of them was ever sold;* Sawyer and Man could accomplish nothing, and in 1879 they closed up; granted a license to Thomas Wallace, and the entire business was transferred to Ansonia. The whole thing had thereafter sunk into oblivion. Prior to September, 1879, the testimony was that not one lamp of all these was successful; not one. They had made no public use of the lamps; they had merely been exhibited to induce people to take stock. There had been no place in that lamp for Sawyer and Man or for Weston to utilize this invention.

In 1879, patents had been issued to Sawyer and Man, both here and in England; meanwhile Weston was still diligently at work upon the problem of the lamp, upon which the beneficial use to the public depended. Beautiful as the first invention was, it was practically useless without the second; and this never came until the latter part of 1880, and then by the complainant company giving to the public the first commercially incandescent lamp. If Weston had been thus diligent, it could not make any difference what others might have done. Now this was not all that had occurred in the Patent Office. Maxim had also filed an application, had been put into interference with Sawyer and Man, and Sawyer and Man had beaten him. Maxim had given a deposition in that case. He had made an experiment which had been spoken of as a public use. It was a lamp, not a treating apparatus; there had not been gas enough in the lamp-chamber to build-up the carbon. Then Maxim had told the real truth, but in his present deposition he has attempted, without much success, to explain away and modify his original statements. This experiment was the only thing he had done prior to 1880. One hundred incandescent lamps had been made under his direction at Bridgeport; 800 more in New York; none of them were sold; they had put up, in the fall of 1880, an advertising plant of 60 incandescent lamps with treated carbons—the very first commercial incandescent plant in public use. Mr. Curtis had testified that it was not until November or December that lamps were made that could be sold. In February, 1881, the complainant company secured a majority of the stock of the Weston Company; Weston in April became the electrician of the United States Company. Mr. Curtis had then consulted him about the machines and processes of manufacture; Weston said to him, "I invented that process of hydrocarbon treatment." Investigation had showed the truth of his statement, and his application for a patent followed; so that the skill came together with the legal title, to the United States Company, and then, as we find by the testimony of Curtis and Hebard, the United States Company had embarked in the manufacture and sale of incandescent lamps. Mr. Hebard says that 10,000 lamps per day were now made with treated carbons, an enormous industry which had been started and built up under the Weston patent.

In reference to the question of infringement, the testimony of complainant's expert, Mr. Pope, had not been questioned, rebutted or touched. It would seem, that with the ability possessed by Mr. Edison, of making lamp conductors of pure vegetable carbon, his company might have refrained from the use of complainant's patented invention.

The complainant, said Mr. Kerr, had supported every allegation in the bill. They felt that Mr. Weston had brought to the knowledge of mankind, one of the most useful as well as one of the most beautiful discoveries ever made; a discovery which had in truth unlocked the secret storehouse of nature. No carbon could be made a perfect conductor except in this way, and in this way any carbon could be made useful. A great, vast, useful territory had been conquered and opened up by this discovery. In 1877 Weston had made this invention, but his work was not done; he had no place in which to use it. Day by day, month by month, year by year, he had patiently wrought to solve the further problem of making that beautiful discovery useful to the public, but not until the fall of 1880 could the place be found in which his incandescent carbon could be made useful. Then, and not until then, did he go to the Patent Office and ask for the well earned reward of his labors. Nobody had been harmed by his delay; nobody had any means of using the invention. The moment a contract could be made with the Government by which he could get the 17 years' beneficial use to which he was entitled, he had applied for his patent. The only defence to that patent was a purely technical defence—a defence wholly without merit. Common justice and common sense required that this patent should be sustained, for this inventor had contributed more to the real benefit and welfare of the public, than had one in ten thousand of those who apply for the protection of the Government for their discoveries and inventions.

STORAGE BATTERY LITIGATION—AN INJUNCTION AGAINST THE ELECTRCAL ACCUMULATOR COMPANY.

On the 2d of December an injunction was issued by the Circuit Court of the United States for the Second Circuit of the Southern District of New York, against the Electrical Accumulator Company, Theodore N. Vail and O. E. Madden, forbidding them from infringing the patents of Chas. F. Brush, March 2, 1886, No. 337,299, and October 17, 1882, No. 266,090, for secondary batteries. The injunction specifies claims 1, 2, 3, 6, 7 and 12 of the first-named patent, and claims 7 and 14 of the second patent. The Consolidated Electric Storage Co. is the licensee of Mr. Brush under his storage battery patents.

STORAGE BATTERY LITIGATION—PERPETUAL INJUNCTION GRANTED BRUSH.

A perpetual injunction was issued in the United States Circuit Court, Trenton, N. J., on Dec. 7, restraining the Accumulator Company from making storage batteries in infringement of the patents of Charles F. Brush, now owned by the Consolidated Electric Storage Company, the successors of the Julien Electric Company.

THE ADAMS ELECTRIC RAILWAY SUITS.

A beginning was made last week in St. Louis, in the suits for infringements of the Adams electric railway patents. Prof. F. E. Nipher was put on the stand by the Adams Railway Co., and testified in support of the Adams side of the litigation, which is directed against the Edison, Thomson-Houston and other electric railway sytems.

Mr. R. Varley, Jr., has lately been appointed superintendent of the large Okonite works at Passaic. In spite of the responsible nature of his duties, Mr. Varley finds time to do a good deal of inventing. Reference was made to another of his patents in the last issue of The Electrical Engineer.

Letters to the Editor.

REACTIVE COILS AND THEIR EFFICIENCY.

In your issue of December 9th, Mr. Otis K. Stuart in a short article on Reactive Coils, accredits me with having first stated that if a magnetic field cut or moved across a conductor a current of electricity would be generated in the conductor. This may be Mr. Stuart's opinion, but of course any one who is familiar with the work of Faraday and others will understand that the principle was known many years before I was born, and is a fact so self-evident that no statement of it would be required, the relation of a conductor to a magnetic field, whether the field or the conductor moves, being perfectly well understood from Faraday's investigations.

Mr. Stuart also says that probably the most interesting application of reactive coils has recently been made by Mr. Elias E. Ries in the Ries regulating socket. If he will refer to my patent No. 428,647, he will see that nothing more is needed than to put that apparatus in practice to obtain the results that Mr. Ries has obtained in the same way. In fact in my house in Lynn, I had several such regulating arrangements for my incandescent lamps, and they were put in operation as far back as 1886. As to the economy of such an arrangement for turning up and down incandescent lamps, that is more problematical, as it is well known that to dim an incandescent lamp by lowering the potential between its terminals reduces its efficiency at so rapid a rate that when it is burning at dull redness and giving scarcely any illumination a very large percentage of the energy is still being expended in producing radiant heat. A Ries regulating socket which I have seen does not even cut out all the reactive coil at the point of maximum brilliancy, though it substantially does so. In so far as it fails to cut out the coil it lowers the brilliancy of the lamp and therefore lowers its efficiency. It is very questionable indeed whether the size of the reactive coil is by any means sufficient for the work which it has to do.

Elihu Thomson.

Lynn, Mass., Dec. 10, 1891.

REACTIVE COILS.

What could Mr. Stuart possibly have had in mind, in making the extraordinary statement which appears in his recent article on "Reactive Coils," to the effect that Professor Elihu Thomson was the first to state the principle "that if a magnetic field cut or is moved across a conductor, a current of electricity would be generated in the conductor"?

Faraday, *Experimental Researches*, vol. i, p. 11 (November, 1831)—introduced one end of a cylindrical magnet, three-quarters of an inch in diameter, and eight and a half inches long, into the axis of a helix, whose terminals were united to a galvanometer, and then "the galvanometer needle being stationary, the magnet was suddenly thrust in; immediately the needle was deflected. * * * * Being left in, the needle resumed its first position, and then the magnet being withdrawn, the needle was deflected in the opposite direction." Again, in vol. i, p. 548, he says:

"A single flat helix was connected with a galvanometer, and a magnetic pole placed near to it; then by moving the magnet to and from the helix, or the helix to and from the magnet, currents were produced indicated by the galvanometer."

F. L. P.

New York City.

MR. LEONARD'S LAW OF MOTOR EFFICIENCY.

In the issue of The Electrical Engineer of Dec. 9, Mr. C. O. Mailloux, in discussing the law I stated as governing the operation of motors of perfect efficiency, makes some statements which seem to be incorrect and to which I therefore wish to call attention.

In my article I discussed a motor whose speed and torque must both be varied to meet the conditions of practical work, and stated that to operate efficiently we must

"Vary the voltage as the speed desired,
Vary the amperes as the torque required;"

and I then described a method by which this result should be accomplished.

Mr. Mailloux finds nothing new in this law and mentions a host of electricians in whose writings it can be found "more or less amplified." I think, however, that it will be difficult to find a motor whose speed and torque are both variable which follows the law as stated. In the shunt motor, the amperes are varied as the torque, but the speed is constant; hence, it is not an example. When a rheostat is inserted in the armature-circuit of a shunt motor, it is true that that portion of the energy which is utilized in the armature follows the law; but the total energy used does not follow the law at all, for the volts are constant from the line under varying speeds, and the efficiency, instead of being a constant, is directly proportional to the speed.

Mr. Mailloux is, I think, in error in stating that in the street-car motors commonly in use the amperes vary as the torque. Such a condition could only be realized in a constant field and with the series fields commonly in use as a constant field is not realized under varying torques, although the commutation of the field is, of course, an endeavor to approximate to it.

In commenting on my suggestion as to the grouping of six motor armatures in various relations from series to multiple while in constant fields, Mr. Mailloux says: "It is scarcely necessary to point out that in this case the torque and speed are both varied and regulated, not by following Mr. Leonard's 'law,' but by varying the counter-electromotive force. The circuit-potential available to the motors may remain constant. The current, on the contrary, will not remain quite constant for all groupings. It is apparent, therefore, that Mr. Leonard's law would be most useful when supplemented by a key to, or list of, its exceptions."

It seems to me that in dividing the total initial electromotive force between the six armatures in series and securing one-sixth speed we certainly "vary the volts as the speed desired;" and I look upon the counter-electromotive force as the *result* of the impressed electromotive force and consequent speed, and not as the *cause* of the speed. Also, there is no question that the current *will* be constant for all groupings, neglecting, of course, the slight effect of the losses in heat, as we do when we speak of a shunt motor as having a constant speed, and a current proportional to the torque.

Mr. Mailloux says: "It is perhaps interesting to point out that in the case of an electric car, a continuous current converter, such as described by Mr. Leonard, would add some 1,500 pounds and two commutators to the car. The objections to the two extra commutators would 'weigh' if anything *more* than the double machine." Although "interesting," Mr. Mailloux's statement is far from correct, as the additional weight will be between 400 and 500 pounds instead of 1,500. The abhorrence of commutators shown by Mr. Mailloux is explained by his statement: "The writer has himself devised methods of regulation employing continuous-current converters in connection with ordinary *series-motors*."

When a commutator is subjected to the severe inductive reactions of a series field, and especially with a rheostat also in circuit, it is not to be classed with a commutator on an armature having no rheostat in series and running in a constant shunt field. A commutator which, in the former case, would spark viciously and continuously, will, in the latter case, run absolutely sparklessly and require no more attention than a well-lubricated bearing.

Mr. Mailloux has been kind enough to grant that my method of operating a motor "will not be without its sphere of applicability and usefulness," which practice has already demonstrated in its commercial application to traveling cranes, where the use of series motors with rheostat control of speed has been attended by such serious drawbacks as to cause certain manufacturers of traveling cranes to quickly appreciate the value of a current and torque automatically proportional to the load and a speed perfectly controllable in either direction from zero to the maximum, and also automatically constant at any desired speed regardless of the load.

H. WARD LEONARD.

NEW YORK.

Society and Club Notes.

THE CANADIAN ELECTRICAL ASSOCIATION.

THE Canadian Electrical Association has been organized at Hamilton, Ont., with the following officers: President, J. J. Wright; first vice-president, H. J. Dunstan; second vice-president; John Carroll; secretary and treasurer, C. H. Mortimer; executive committee, E. S. Edmonson, H. O. Fisk, W. A. Johnson, S. J. Parker, A. B. Smith, D. Thomson, Thos. H. Wadland, A. A. Wright and John Yule.

THE AMERICAN INSTITUTE.

AN electrical section of the American Institute has recently been organized with the following officers: E. T. Birdsall, president; Dr. L. H. Laudy, vice-president; J. W. Hull, secretary. The section will meet on the second Wednesday of each month at the rooms of the Institute, 115 West 38th street. This section will be similar to the polytechnic, photographic and other sections of the Institute. We must confess that this step seems to us unnecessary and inadvisable. There are now three active electrical bodies in New York, which between them cover the field very thoroughly. Moreover, the New York Electrical Society for some years tried to act as an electrical section of the moribund American Institute and at last retired in disgust under Prof. Crocker's leadership. It has not since had any occasion to regret its action.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The 62d meeting of the Institute will be held at 12 West 31st street on Wednesday evening, December 16th, at 8 o'clock. A paper will be read by M. I. Pupin, Ph. D., on "Polyphasal Generators." Postponed discussions on Prof. Harris J. Ryan's paper and the Report of the Committee on Units and Standards will be in order, if time permits.

Literature.

CASSELL'S RECORD OF SCIENTIFIC PROGRESS.

THIS time-honored publication is now in course of preparation, covering the year 1891, under the able charge of Mr. Robert Grimshaw, No. 21 Park Row, New York. We are requested to inform our readers that Mr. Grimshaw will be glad to receive the details of their work in scientific lines for insertion in the Record.

AN EDISON CONFERENCE.

DURING the past week an important conference of the Edison district managers and heads of departments was held. A preliminary meeting was held in Chicago on Monday, and the business was resumed later in the week in the East, part of the time being given up to visits to Schenectady, the New York Works and the Lamp Works at Harrison, N. J. It is understood that a number of leading matters were discussed at the conference, which lasted several hours daily, and that the officers of the company are very much pleased at the results, both in the interchange of ideas and facts and in the showing made as to the stability and progressiveness of the Edison business throughout the country. No details of the topics touched upon are obtainable, however.

The conference was closed on Saturday evening, by a banquet at Delmonico's given by the second vice-president, Mr. Insull, in honor of Mr. Edison, when 29 gentlemen sat down at table. Mr. Insull had Mr. Edison on his right and Mr. Villard on his left. There were also present First Vice-President Herrick; District Managers Shain, Mitchell, Beggs and Reece; Mr. E. H. Johnson; Mr. C. Batchelor; Mr. John Kruesi and Mr. E. Gilmore, managers of the Schenectady Works; Mr. Francis R. Upton, manager of the Lamp Works; Mr. John Langton, manager of the Canadian Works; Mr. Hutchinson, manager of the New York Works; Mr. Henderson, chief engineer of the Edison General Co; Mr. Kennelly, electrician of the Edison laboratory; Mr. Hastings, treasurer of the Edison General Co.; Mr. Muir, manager of the electric railway department; Mr. Dana Greene, manager of the light and power department; Mr. J. Kelly, manager of the wire department; Mr. Lemaire, manager of the fixture department; Mr. Ord, comptroller of the Edison General Co.; Messrs. Tate and Butler, of the executive department; Mr. Arango, of the Spanish Edison Co.; Messrs. Eaton and Lewis, of the legal department; and Mr. H. W. Darling, special agent. Among those who participated in the conference but were unable to attend the banquet were Messrs. Coster, Barr, Paine and Glass, of the District offices.

The toast of the evening—that of Mr. Edison—was appropriately proposed by President Villard, and acknowledged by Mr. Batchelor, as one of Mr. Edison's oldest associates. The "District Managers" toast was responded to by "Oregon" Mitchell. Major Eaton then gave some interesting reminiscences of the early days, as the first president of the original Edison Co.; and he was naturally followed and, in the same vein, by Mr. E. H. Johnson, who was never more eloquent and felicitous, and who took occasion to express feelingly his great pleasure at the success now being achieved by his old protégé and associate, Mr. Insull. This graceful tribute of esteem and friendship, coupled with a toast, was neatly and sympathetically replied to by its recipient; and speeches were also made by Messrs. Herrick, Ord, Henderson, Beggs, Kennelly, Kruesi and Upton.

ELECTRICAL EXECUTION.

A MURDERER named Loppy was executed at Sing Sing last week. The execution was "instantaneous" and "successful" of course. It required four contacts extending over a period of six minutes. Loppy was killed by the first contact, it is said, and the other three were "thrown in," simply to make sure.

A NEW ENGINEERING FIRM—SPRAGUE, DUNCAN & HUTCHINSON, LTD.

A CORPORATION under the above name has just been formed in this city and has opened its offices at 15 Wall street, under the business managership of Mr. Alfred Bishop Mason. It is no exaggeration to say that this is one of the most important happenings of a very eventful year in the field of electrical engineering. Mr. Frank J. Sprague is justly recognized as one of the foremost men in the profession, while his work in electric railroading at once lifts him into the category of historical pioneers. The record of electrical triumphs in America will be incomplete if it does not give large space to his inventions and achievements in electric railways. Mr. Sprague has of late made a special study of rapid transit problems. In order to devote his time to the new firm he has resigned as consulting engineer of the Edison General Electric Co. The second member of the firm is Dr. Louis Duncan of Johns Hopkins University, who has been constantly before the electrical public since the memorable lamp tests at the Franklin Institute in 1884, and whose contributions to electrical science and its literature have been neither few nor mean. It is understood that Dr. Duncan is shortly to drop his important professional duties at Johns Hopkins, (where he created the Electrical Laboratory,) and give himself up to this work; toward which he has always had strong inclination. Dr. Cary T. Hutchinson, also a Johns Hopkins man, has served as electrical engineer with the old Sprague and new Edison General Companies, and was for a time assistant to the chief engineer of the latter corporation. More recently he has been engaged on the mathematical and experimental work connected with some of the later Sprague inventions.

Frank J. Sprague.

Dr. Louis Duncan.

This firm, with its high personal reputation and many influential connections, is destined to play a conspicuous part in electrical engineering, and may be counted upon to help raise the standard of a rapidly advancing profession. It will make a specialty of consultation work, whether for bankers and investors, cities dealing with electrical questions, mines or mills desiring to utilize electric power, street railroad companies, or steam railroads proposing to handle suburban traffic by electricity. As we have said before, to employ the services of a first-class engineer in regard to new schemes, or the status of existing enterprises, is never an expense but an economy. With the return of business prosperity, now so close at hand, electricity will be the great and favored field for investment, and more than at any time before will the consulting electrical engineer act in a responsible and useful capacity. The sentiment of the electrical community as a whole is voiced in the hope that this newly formed company may enjoy a large measure of public patronage and support.

Dr. Cary T. Hutchinson.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED DECEMBER 8, 1891.

Accumulators:—

Secondary Battery, I. L. Roberts, 464,665. Filed Dec. 31, 1890.
A secondary battery having an electrolyte composed of the salt of iron capable of absorbing an acid radical, and a non-porous electrolytic diaphragm interposed between the electrodes.

Electrode for Secondary Batteries, W. Morrison, 464,676. Filed Oct. 27, 1890.
Provides means by which the materials composing the plate are confined and at the same time allow afree circulation of the gases or solution to and from the plates in charging and discharging.

Clocks:—

Electric Programme-Clock, C. Lester, 464,730. Filed Apr. 10, 1891.

Distribution:—

System of Distributing Electricity, T. A. Edison, 464,822. Filed June 26, 1882.
Has for its object the utilization of high-tension currents on the main conductors of an electric lighting system having incandescent lamps, motors, etc., arranged in multiple arc and requiring a current of lower tension.

Dynamos and Motors:—

Armature Winding for Dynamo-Electric Machines, C. R. Arnold, 464,547. Filed Mar. 14, 1885.
Has for its object to avoid the inequality in the length and resistance of the various armature coils as well as to secure other advantages.

Electro-Magnetic Motor, N. Tesla, 464,666. Filed July 13, 1891.
Has for its object to secure artificially a difference of a quarter of a phase between the currents in the two energizing circuits of an alternating motor.

Transformer-Motor, O. T. Blathy, 464,671. Filed Nov. 8, 1889.
Consists of an electric motor for alternate currents dispensing with the introduction of the current by commutator and brushes.

Automatic Cut-Out for Electric Motors, S. S. Wheeler, 464,948. Filed July 16, 1887.
Consists of a cut-out controlling the connection of a motor and adapted to automatically disconnect the motor from the circuit upon the occurrence of any undesirable condition of running.

Lamps and Appurtenances:—

Electric Arc Lamp, A. G. Waterhouse, 464,682. Filed April 1, 1891.
Method of simplifying the operation and construction of arc lamps.

Incandescent Lamp Filament, L. K. Böhm, 464,719. Filed Jan. 2, 1890.
A filament consisting of carbonizable material impregnated with carbonates of calcium or magnesium.

Measurement:—

Time-Registering Device for Electrical Currents, W. D. Wilder and W. Cobb, Jr., 464,540. Filed Nov. 18, 1889.
Registers automatically the length of time an electric lamp or motor is being used.

Electric Meter, A. G. Waterhouse, 464,683. Filed April 10, 1891.
Electro-chemical meter whereby the current is measured by the electrical decomposition of a fluid.

Metallurgical:—

Ore Separator, W. G. Conkling, 464,816. Filed Sept. 19, 1889.
A magnetic ore separator.

Process of Obtaining Metals from their Ores or Compounds by Electrolysis, C. S. Bradley, 464,933. Filed Feb. 23, 1883.
Claim 1 follows:
Process of obtaining metals from their ores of compounds, consisting of passing an electric current through a fused portion of the ore or compound contained in an unfused body or heap of said ore or compound.

Miscellaneous:—

Electric Fare-Recording System, B. S. Molyneux, 464,518. Filed Feb. 28, 1891.
Has for its object to record fares taken on an electric railway car at points distant from the car itself.

Cut-Out, C. R. Arnold, 464,548. Filed June 11, 1891.
Claim 1 follows:
A fusible cut-out consisting of an open glass tube having metal ferules at the ends and a fusible strip within fastened to said ferules.

Lightning Arrester, E. Thomson, 464,595. Filed Oct. 11, 1890.
Consists of a continuous conductor connected to ground and so arranged as to form a series of disruptive insulation spaces of a total resistance sufficient to prevent the passage of much of the line current to earth.

Electrical Condenser, N. Tesla, 464,667. Filed Aug. 1, 1891.
An electric condenser composed of plates or armatures immersed in oil and adjustable in respect to one another.

Drill for Electric Railways, H. P. Bradford, 464,678. Filed July 27, 1891.

Electrical Transformer, A. Poleschko, 464,677. Filed April 17, 1891.
Consists of a core of spaced iron plates having a vertical slot containing the primary coils and another slot at right angles to the first containing the secondary coils.

Electric Body-Wear, L. Anderson, 464,691. Filed Mar. 16, 1891.
An electric belt.

Clamp for Electric Wires, J. J. Green and G. C. Brown, 464,770. Filed Oct 30, 1890.
An insulating clamp adapted to hold firmly various sizes of insulated wires. (See THE ELECTRICAL ENGINEER of Dec. 2).

Railways and Appliances:—

Electric Railway-Signal, C. E. Buzzell, 464,490. Filed June 20, 1891.
An arrangement for automatically indicating the positions of semaphores, etc., at any desired point.

Conduit-Conductor for Electric Railways, W. H. Knight, 464,505. Filed Aug. 4, 1888.
Claim 4 follows:
In an electric railway the combination of a sectional supply conductor with safety devices normally included in circuit between succeeding sections thereof.

Electric-Railway System, L. O. Dion, 464,557. Filed Dec. 5, 1890.
An arrangement by which in a storage-battery system of electric traction the battery may be charged while the cars are in motion.

Carriage-Actuating Mechanism, W. H. Phillips, 464,587. Filed Feb. 2, 1891.
Relates to automatically controlling the movements of vehicles.

Electric Track Signal, H. A. Parrish, 464,655. Filed Mar. 9, 1891.
A railway signal actuated by the passage of the wheels of the locomotive over a tead-bar which completes an electric circuit.

Transmitting Mechanism for Motor Cars, C. W. Thomas, 464,640. Filed Jan. 23, 1891.
Claim 2 follows:
A combination with the track wheels and with the transmitting mechanism of the motor car of the four systems of optionally applied normally inactive brakes whereby the car can be started at the desired speed or brought to rest.

Trolley for Electric Railways, J. W. Schlosser, 464,780. Filed Aug. 10, 1891.
A jointed trolley arm the two parts of which are connected by a lash automatically tripped.

Telegraphs:

Automatic Fire-Alarm Telegraph, M. Martin, 464,510. Filed Feb. 21, 1887.

Telegraph Key, L. F. Robare, 464,897. Filed June 4, 1891.
A simple legless telegraph key from which the regular binding posts are omitted.

Telephones and Apparatus:—

Spring Jack Switch, W. R. Patterson, 464,519. Filed May 27, 1890.
A switch for use on telephone exchange boards obviating damage to the electrical connection resulting from accumulation of dust.

Means for Preventing the Interference with Speech on Telephone Circuits by Induced or other Currents, W. Stanley, Jr., J. F. Kelly, 464,529. Filed May 22, 1891.
Has for its object the elimination of induced currents by means of placing a receiving instrument in a portion of the circuit adapted by the adjustment of its self induction and capacity to oppose the passage of current waves below a certain frequency.

Protector for Telephones, J. L. W. Zietlow, 464,643. Filed March 31, 1891.
Relates to a method of protecting telephone and telegraph wires from the damaging influence of powerful currents.

Patent Notes.

AN EDISON PATENT FOR CONNECTING "TENSION REDUCING" DEVICES IN MULTIPLE ARC.

On December 8, a patent was issued to Mr. T. A. Edison, entitled "System of Distribution," No. 464,822, which will attract considerable attention owing to the broadness of the claims embodied in it. The patent was filed June 26, 1882, and describes the method of employing a high-tension main circuit extending to a distant point and "tension-reducers" located at a distance from the point of supply and connected with the high-tension circuit in multiple arc so as to be independent of one another, the lamps or motors on the derived low-tension circuit also being connected in multiple arc.

One method of accomplishing this object is described, consisting of secondary batteries or condensers which are charged in series from the high-tension circuit and discharged in multiple into the low-tension circuit, this being accomplished by means of a revolving commutator.

The patent was the subject of prolonged interference proceedings; its claims are as follows:

1. In a system of electrical distribution, the combination of a main circuit extending to a distance from the source of electrical energy and having a current of high tension, a constantly-acting tension-reducer connected with such main circuit by a multiple-arc or cross circuit, so as to be independent of other similarly-connected tension-reducers, and a translation-circuit supplied by such tension-reducer with a current of lower tension, substantially as set forth.

2. In a system of electrical distribution, the combination of a main circuit extending to a distance from the source of electrical energy and having a current of high tension, a translation-circuit, translating devices arranged in multiple arc in such translation-circuit, and a constantly-acting tension-reducer connected with such main circuit by a multiple-arc or cross circuit and also connected with said translation-circuit, said tension-reducer being charged from such main circuit and discharging a current of lower tension in said translation-circuit, substantially as set forth.

3. In a system of electrical distribution, the combination of a main circuit extending to a distance from the source of electrical energy and having a current of high tension and a translation circuit with an intermediate secondary battery or condenser, and a continuously-working commutator throwing all the elements of such secondary battery or condenser together and at the same time rapidly form a series connection with the main circuit to multiple-arc connection with the translation-circuit, and back again, substantially as set forth.

4. In a system of electrical distribution, the combination of a main circuit extending to a distance from the source of electrical energy and having a current of high tension, and a translation-circuit with an intermediate secondary battery or condenser, a commutator throwing all the elements of such secondary battery or condenser together and at the same time rapidly form a series connection with the main circuit to a multiple-arc connection with the translation-circuit, and an electric motor working such commutator, substantially as set forth.

The Edison Company claims that the patent covers the placing of converters or transformers in multiple arc.

ELECTRIC RAILWAYS—HUNTER vs. POPE.

Commissioner Simonds, on November 28, decided an interference of long standing between Rudolph M. Hunter and Franklin L. Pope, involving an important invention in circuits for electric railways in favor of Pope, reversing the previous decisions of the Examiner of Interferences and the Board of Examiners-in-Chief in favor of Hunter. The points involved were similar to those in the recently decided interference of Hunter *vs.* Jenkin.

CENTRAL ELECTRIC CO.

There have been a great many switches placed upon the market during the past year, but for quality and satisfactory results in every day use, the Bryant switch, it is claimed, has not been surpassed. The Central Electric Company, who are the general Western agents for this switch, have no reason to be afraid of a waning popularity, as some recent handsome orders attest.

The Central Electric Company's Chicago city trade has become of such importance and consideration, that they have been obliged to put on a special delivery wagon. In doing so, they have selected a wagon of original design and artistic appearance, which excites comment wherever it goes.

The Central Electric Company report a splendid business in their Improved Candee weather-proof wire, and Special Candee feed wire, for electric railways. These wires are the product of the Okonite Company, and are up to the high grade of this well-known company's products.

The method of giving away goods as a business policy to secure orders, is a novel one in the electrical business, and the Central Electric Company are entitled to the credit of this departure, which, they say, has been happily received by the trade, and has netted good results thus far.

"THEY COVER THE GROUND."

To the Toronto Construction and Electrical Supply Co., Toronto, belongs the credit of being the first wholesale electrical supply house in Canada to canvas the entire Dominion by means of capable traveling representatives, who each carry with them several sample trunks filled with the latest and best novelties for electrical uses. At the present time, one representative is in British Columbia, another in Halifax, N. S., and four others are at various points between the two first mentioned, which are nearly 4,000 miles apart, and as a result of such a progressive policy, the business of the company has increased with great rapidity. All purchases made by the Toronto Co. are for prompt cash, and consequently they buy to the best advantage.

ELECTRIC LIGHTING IN THE MARITIME PROVINCES.

The Moncton Sugar Refining Co., of Moncton, New Brunswick, are now equipping their buildings with an electric light plant, which is being installed by John Starr, of Halifax, who has also contracted to light the Pyrites Mining Company's property at Pilley's Island, Notre Dame Bay, Newfoundland; and the plant is now being installed under the superintendence of his electrician, Mr. C. A. Hoyt. The offices, stores, dwelling houses, wharves and tramway, besides the shafts and underground workings of the mine, will all be lighted by incandescent lamps of 16 c. p. each.

Mr. Starr, who is one of the pioneers of electric lighting in Canada, is general agent in Canada for the "Lahmeyer" system of dynamos, which are giving entire satisfaction in several factories which have lately been equipped.

Mr. B. Frank Johnson, of the Interior Conduit and Insulation Co., has removed from the Provident Building, Phila., to the office of Walker & Kepler, 531 Chestnut street, with which firm he is now associated in the Conduit Company's interest. This change was made necessary owing to the increasing demand for the more prompt delivery of the conduits and other products from the company's factory. Mr. Johnson reports having recently closed several large contracts in which metal-covered tubes will be exclusively used, and that the leading architects and builders are enthusiastic in their advocacy of this new conduit, as well as of the many other improved devices recently designed for the simplification and efficiency of the Interior Conduit Co.'s system of electric wiring.

Mr. W. S. Ford, long time superintendent of the Colorado Telephone Co. has been given the post of superintendent of Bell telephone underground work, with headquarters in Boston.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT

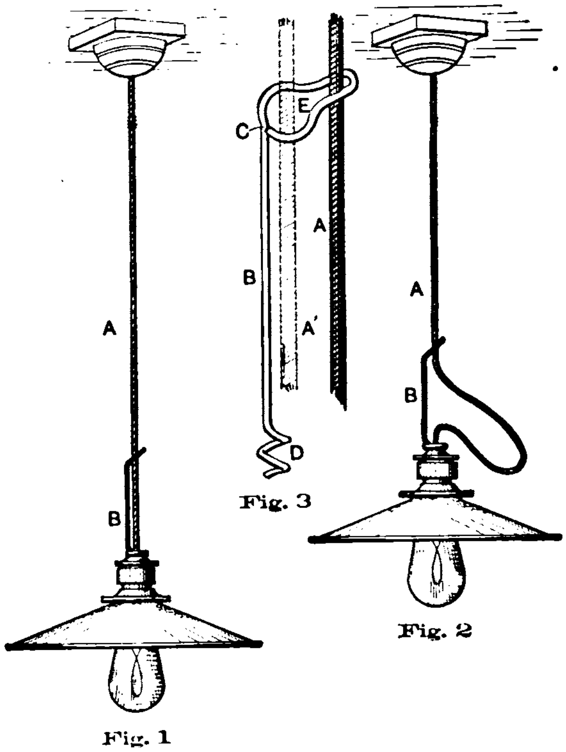
Choose your advertising mediums as you would your friends.

THE SCHENCK CORD ADJUSTER FOR SUSPENDED LAMPS.

THE necessity of a simple and effective cord adjuster by means of which an incandescent lamp when not in use may be readily and quickly moved out of harm's way, has led Mr. Unico H. W. Schenck, of Brooklyn, to devise the arrangement shown in the accompanying illustrations.

As will be seen, Figs. 1, 2 and 3 represent the adjuster in operation. It consists of a wire rod one end of which is rigidly attached to the lamp socket, and the other fashioned into a goose-necked loop, through which the flexible cord passes.

The device is attachable to any make of socket without discon-



SCHENCK LAMP-CORD ADJUSTER.

necting the cord. In Fig. 3, A represents the cord caught in the neck of the loop, and A', when the lamp is at its lowest point as in Fig. 1. Here B is the stem; C shows the end of the loop disjointed that the cord may be sprung into position without disconnecting it. The spiral end D around the cord fits into the hole in the socket used when the latter is attached to a bracket, and is held in place by the set-screw. The raising of the lamp is effected by simply allowing the cord to run through the large end of the loop in the rod and when the proper height is reached, catching it in the narrowed end. It can be operated by one hand.

This device is manufactured by the National Speciality Co., 720 Fourth avenue, Brooklyn, N. Y.

THE AKRON ELECTRICAL MANUFACTURING COMPANY.

THE above concern of Akron, O., has just closed contracts for the following machinery and apparatus: Four 40,000 watt incandescent dynamos, one 15-light arc dynamo, ½ h. p. motor and one 5 h. p, motor, to be placed in the new fireproof Lexington Hotel, at Chicago, Ill.; one ½ h. p. motor for Stanley & Co.'s coffee house, Akron, O.; one 50 light incandescent plant for the Akron Machine Co.'s works, Akron, O They have also sold five of their well-known Loomis fire-alarm boxes to be placed in various manufacturing establishments in Akron, and two to be included in the fire-alarm system of the city of Zanesville, O. Mr. W. D. Chapman, the general manager of the company, erports the outlook for new business as quite flattering.

MR. CHAS. E. CHAPIN.

MR. CHAS. E. CHAPIN, Electrical Exchange Building, New York, Rooms 417 and 418, announces his readiness to serve as buyer for all or any electric companies requiring machinery, material or supplies.

Mr. Chapin has had a large experience as an official in electric companies, and was for a long time the purchaser for the Sawyer-Man Electric Co., of New York. For the past year he has done the buying for Alexander, Barney & Chapin, of this city, but has recently resigned his position with that company.

Mr. Chapin's long and wide experience in the market for electrical goods would seem to guarantee careful and expert attention to any business entrusted to his hands. His character for probity and energy is well known to the electrical fraternity.

BALL & WOOD CO.

THE new plant of the Ball & Wood Co., builders of the Improved Ball automatic engines, is so far completed that shipments of engines have commenced, and the works have been running night and day since October first to clear up their order books. During the recent meeting of the Society of Mechanical Engineers in New York, the Ball & Wood Company had the pleasure of entertaining many of the members who took advantage of the proximity of the works to run out and inspect them and extend their congratulations. Orders for the Improved Ball engines have already been executed as follows: 150 h. p. for the State House, Trenton, N. J.; two 150 h. p. for the Edison Electric Illuminating Co., of Paterson, N. J.; 75 h. p. for the Saugerties Electric Light Co , Saugerties, N. Y.; 100 h. p. for the Meriden Electric Light Co., Meriden, Conn.; 75 h. p. for the Edison General Electric Co., Rockledge, Fla,; 100 h. p. for the Leominster Worsted Co., Leominster, Mass.; 150 h. p. for R. H. Macy & Co., New York; two 75 h. p. for the Four Seasons Hotel, Cumberland Gap, Tenn.; 150 h. p. for the Electric Light Co., Madison, N. J.; 150 h. p. for the Laconia Car Co., Laconia, N. H.; 300 h. p. cross-compound for the Edison Co., of Paterson, for street railway service.

WESTON ELECTRICAL INSTRUMENT CO.

THE WESTON ELECTRICAL INSTRUMENT COMPANY, Newark, N. J., has taken a contract to build a 5,000-ampere ammeter for the Wilson Aluminum Company, of Leaksville, N. C. This instrument is to be a very large form of the well-known Weston type of ammeter, with some important modifications to meet the peculiar requirements of the case. It will have a scale about 14 inches long, which will be divided into 250 parts. Each division will equal 20 amperes, and the divisions will be large enough to be easily read to tenths or 2 amperes, and with care to 1 ampere. The scale will be laid out by actual calibration to the full current to be measured by the instrument in practical work, namely 5,000 amperes. This may seem a somewhat astonishing thing for the Weston Company to do, especially when we consider the work which is commonly done by the use of a current of 5,000 amperes. Thus in incandescent lighting with the direct current, each 16 c. p. lamp requires about .5 ampere. The current required to standardize this instrument would therefore run 10,000 incandescent lamps. Notwithstanding the enormous strength of the current required, it is not beyond the facilities of the Weston Electrical Instrument Company to handle it in the regular course of their work, without a single change in their appliances or any special preparation.

The appliances of the company for standardizing work are generally known to be excellent, but we imagine it will be news to our readers to learn that any instrument-making firm in the world was in a position to command in its laboratory such enormous currents as those referred to. It is a fact, however, that this concern is already equipped to do this gigantic work.

Some idea of the perfection of the Weston Electrical Instrument Company's plant in this respect can be formed when we state that the copper conductors in the laboratory for handling ammeter work weigh about 4 tons and that some of the mains have a sectional area of 5 square inches, and that they are capable of carrying a current of 10,000 amperes without inconvenient heating.

THE SCHULTZ BELTING CO., of St. Louis, Mo., have just sold two "Woven Leather" link belts to the Citizen's Electric Railway Co., of Decatur, Ill.; fifteen in the State of Montana; five in the State of Washington; one flat belt, 48 inches wide, heavy double, to the Municipal Electric Light and Power Co., of St. Louis, who have been using one of their 48-inch double belts for 19 months. Also one double belt to Clinton, Mass., 30 inches wide and 175 inches long, and one 36 inches wide and 210 inches long.

H. WARD LEONARD & CO.

H. WARD LEONARD & Co. have secured the contract for wiring the *Mail and Express* Building for 3,500 incandescent lamps, acting as sub-contractors under the Waddell-Entz Electric Company.

They have also received an order from Wm. Sellers & Co., of Philadelphia, for two 40 h. p. motors for use upon traveling cranes. The motors are to be supplied under rigid specifications, as to dimensions and performance; but the decision as to the particular make of motors to be used is left with H. Ward Leonard & Co.

Mr. Leonard is now licensing various manufacturing and construction concerns under his recently patented system of motor regulation. The basis of the license is a charge $2.50 per K. W. (roughly per horse-power) in the motor. The royalty charge is not an annual charge, but is paid once for all in each case. Wm. Sellers & Co., have taken a license under Mr. Leonard's patent on this basis, they agreeing to use the method upon all electric cranes they build in the future during the life of the patent. The royalty is so small that the method will probably be rapidly introduced wherever it is applicable.

NEW HEISLER INSTALLATIONS.

THE HEISLER ELECTRIC LIGHT Co., of Philadelphia, report the following business:

Carroll Electric Light Works, Matteawan, N. Y. (increase of plant) 600 32 c. p. lights capacity. Messrs. Rheubottom & Bond, Union City, Mich. (increase of plant) 200 32 c. p. Merced Gas and Electric Light Co., Merced, Cal. (increase of plant) 400 32 c. p. Glazier-Strong Oil Stove Co., Chelsea, Mich., 200 32 c. p. Messrs. Cortright & Son, Homer, Mich., 160 32 c. p. Kingman Water and Light Co. (increase) 200 32 c. p.

The municipal plant now being installed by this company at West Toronto Junction, Ont., Can., is nearing completion, and the lights will be in operation very shortly.

The company also report a large and constantly increasing demand for their series lamps for use on arc light circuits.

PHILADELPHIA NOTES.

GEO. CAMPBELL & Co., who were recently burnt out at Washington Ave., have leased and are fitting up the mill at Clifton of the Longstreth estate. As part of the new equipment they have ordered of Messrs. M. R. Muckle, Jr., & Co., a 9-inch Westinghouse compound engine and a 300-light dynamo. Messrs. Muckle & Co. have also sold to the Onderdonk Heating and Ventilating Co. a 25 h. p. Jr. Westinghouse engine to drive the electric light plant and other machinery in the building of the Scott Paper Co., of Philadelphia.

MR. W. A. STADELMAN, of the Equitable Engineering & Construction Co., has closed a contract with the Curtis Bay Railway Co. of Baltimore, Md., for a complete electric outfit for their road. Mr. A. H. Rutherford and Mr. W. C. Sedden, the proprietors of the road, have, it is said, secured large blocks of stock in the new Edison lighting station which will soon be in operation.

THE PARTRICK & CARTER Co. have achieved a world-wide reputation on their King annunciators, and during the past year they have shipped these annunciators to nearly all parts of the civilized world. Last week they received orders from Moscow, Russia, and Constantinople, Turkey.

THE SPELLIER ELECTRIC TIME Co. held its annual meeting of stockholders last week, and elected Mr. H. B. Cutter president and general manager, and Mr. E. M. Dobelbower secretary and treasurer. The treasurer's report showed the company to be in a prosperous condition.

MR. L. K. PEROT, of the Equitable Engineering & Construction Co., is a benedict, having married last week Miss Jessie Hannis, daughter of one of our most prominent lawyers, Mr. William C. Hannis. They are spending their honeymoon in the South.

MR. J. W. PARKER has sold a 150 h. p. cross compound condensing engine to the Rock Creek Electric Railway Co., of Washington, D. C., and 150 h. p. standard engine to the Lynchburg, Va., Electric Railway Co.

THE AJAX METAL Co. are installing an incandescent plant in their factory on Richmond street, and have let the contract to the Pennsylvania Electric Engineering Co.

MR. GEORGE B. SHAW, general manager for the National Electric Manufacturing Co., Eau Claire, Wis., paid a flying visit to Philadelphia last Monday.

THE BINGHAM HOUSE are about to put in their own plant which will comprise two 500-light incandescent dynamos.

THE PENNSYLVANIA ELECTRIC ENGINEERING Co. have secured the agency for New Jersey, Pennsylvania and Delaware for the Ries regulating sockets.

QUEEN & Co. say that the demand for their new Wagner-Queen voltmeter has been away beyond their expectation.

NEW ENGLAND NOTES.

CAPT. A. DE KHOTINSKY, accompanied by his family, arrived this week in Boston, and will now be permanently attached to the staff of the Germania Electric Company, of Boston, as electrician of the company. Capt. De Khotinsky has for years been manufacturing incandescent lamps at Rotterdam and Frankfort, but will now devote the whole of his time to their manufacture in the States. The lamp which bears his name, and which was invented by him, has become very favorably known in Europe, and is remarkable for its enormous range as regards voltage, candle power and efficiency, running from 5 to 200 volts, from 4 to 300 candle-power, and from 1¼ to 5 watts efficiency.

THE REDDING ELECTRIC COMPANY, of Boston, are rapidly developing a very large trade in the East for the aluminium carbons, for which they are the sole New England agents, and which are becoming very popular. Their business in the well-known Redding watchman's clock is also increasing, and the company are on the outlook for live agents in all parts of the country to whom they would give exclusive territorial rights.

WESTERN NOTES.

THE ELECTRIC MERCHANDISE Co. have the Burton electric heaters in daily operation on 90 roads. This shows a remarkable appreciation of their advantages and commercial practicability. The number in use is rapidly and continually increasing. It is needless to say that in every case they are giving entire satisfaction. These heaters are also in use for house heating and in office buildings and are a great success. Those who are still skeptical as to the economy and practicability of this means of heating should write the above company, who will be glad to furnish full details.

THE POND ENGINE Co., through their Chicago office, have closed a contract to replace the 60 h. p. Armington & Sims engine in the American Express Company's building on Monroe street with an engine of the same make of 120 h. p. The present engine will be moved to the express stables on Sebor street to operate the lighting plant in that building. For the past nine years the American Express Company's plant has been operated by an Armington & Sims engine, which has given such good satisfaction that the present order was secured in spite of unusually sharp competition.

MR. F. DAY VOORHEES, the popular general agent of the Norwich Insulating Wire Co., of New York, was a visitor to Chicago last week looking after the sale of his paper wire for underground and interior use. Mr. Voorhees reports that he has got a large amount of cable working on underground arc lighting circuits here, and that it is giving the most eminent satisfaction. In fact, no trouble at all has ever been occasioned by it, which speaks highly for the insulating qualities and manufacture of the cable.

MR. W. J. PILICY, well known in Eastern and Western electrical circles, has united himself with the Illinois Electric Material Co. as their selling representative. Mr. Pilicy is popular among the electrical fraternity in the West and will no doubt command his full share of the trade.

MR. WM. HOOD is the only customer of the Chicago Arc Light & Power Co. who can look on their recent burn-out with smiling complacency, as he throws on his "Jewel" incandescents just the same as ever. This is one of the cases where the storage battery comes to the front.

MR. E. C. OLDACRE, general agent of the Jenney Motor Co., was a caller at the Western office of THE ELECTRICAL ENGINEER last week. He has been spending some time in Chicago looking after some important deals, and his many friends in this city are always glad to see him.

MR. CHARLES B. COON, of Hill clutch fame and the manager of the Chicago office of that firm, has returned from some recent business trips, upon which he succeded in placing a large amount of their well-known clutch and shafting work.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

VOL. XII. DECEMBER 23, 1891. No. 190.

THE NICHOLSON ELECTRIC HOISTING AND CONVEYING MACHINE.

THE application of the electric motor to the many forms of hoisting devices has engaged the attention of electrical and mechanical engineers within the past few years to an extent that has perhaps not been fully appreciated by those not directly connected with the development of this department of electro-mechanics. Of this class of apparatus the machine recently produced by the Nicholson Electric Hoist Company, of Cleveland, Ohio, is entitled to consideration as occupying a field not hitherto invaded by the electric motor—that of unloading ore and coal from vessels at docks, and hoisting and conveying the material to stock piles or freight cars convenient for future movement.

The Nicholson machine is the invention of Mr. Ezra Nicholson, of Cleveland, and is shown in the accompanying engravings made from photographs taken of the first plant installed on the docks of the Cleveland Rolling Mill Company. The apparatus consists of a drum hoist, electric motor and controlling devices mounted upon a tram-car constructed of light steel I beams.

The gauge of the car is five feet, wide enough to admit of hoisting the loaded bucket between the girders and up into the tower of the car. In operation the tram-car is run out on the boom directly over the hatch of the vessel and the bucket lowered by gravity, being controlled by a brake on the hoisting drum. The motor is disengaged from the gearing on the axles of the car and thrown into gear with the hoist by a single movement of a clutch lever. The controlling-switch is moved to turn on the current, and the loaded bucket is hoisted at the rate of 5 feet per second vertically to the frame of the car. When the sheave-block reaches the top frame it is locked automatically, and at the same time the power is transferred to the car axles, and the car moves along the tramway at the rate of 20 feet per second to any desired point, where it is stopped by the operator.

The loaded bucket is then tripped by the operator and the contents are dumped on the stock pile, or the bucket lowered to a freight car and there dumped by the operator, who hoists the bucket to the tram-car and returns for a new load. The time occupied in actual work in hoisting a loaded bucket of ore weighing 3,000 lbs. and carrying the load 200 feet, dumping and returning for a new load, is 55 seconds. The time occupied in accomplishing the same work by the steam automatic cable systems is 70 seconds.

The tramway upon which the machine moves is elevated 35 feet above the surface of the dock, and is so arranged mechanically as to admit of lateral movement along the dock, the front and rear frames resting upon tracks for that purpose. The front boom of the tramway is run out over the vessel's hatchway, being supported by guys, as shown in the photograph, and in order to allow the vessel to leave the dock, the boom is folded up and rests against the front frame.

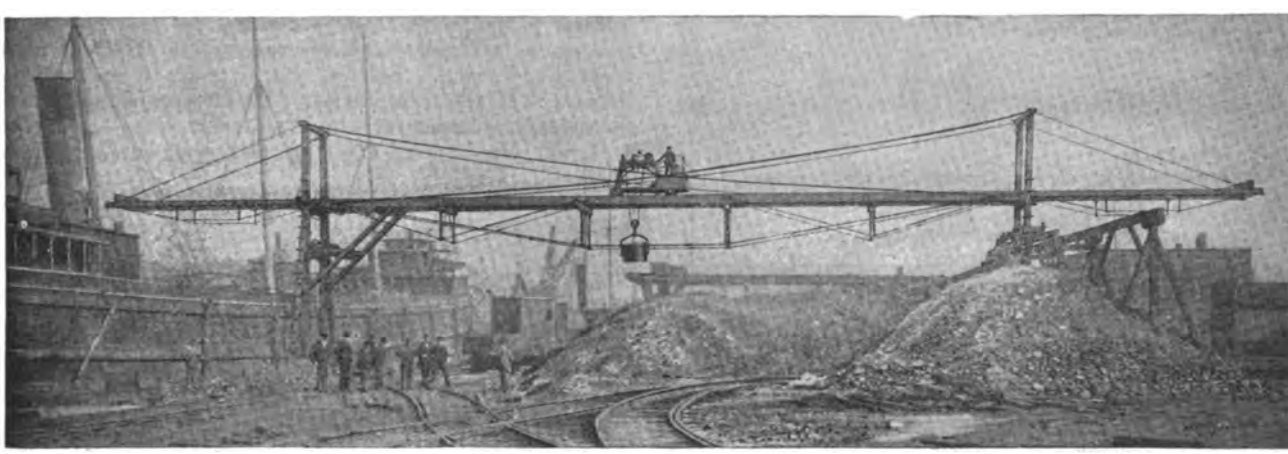


FIG. 1.—THE NICHOLSON ELECTRIC HOIST AT WORK ON THE ORE DOCKS, CLEVELAND, O.

Power for the motor is obtained from a station located near by, and a trolley wire is located upon the top of one of the girders. The trolley-wheel, by a downward contact, feeds the motor. The motor is perfectly insulated from the frame of the car, as is also the hoisting drum and wire rope. A ground wire is connected to the wheels of the car, and the rails are all bonded and grounded to water pipes adjacent.

The carrying out of the mechanical details of this electrical hoisting and conveying system, has been very carefully accomplished by W. P. Williams, engineer of the company and member American Society Civil Engineers, before whom the plan of operation was recently explained. Mr. Williams' plans for the operation of a large plant are very complete. By taking advantage of the intermittent character of the work, the power plant may be much smaller than the total combined power of the hoists, so that great economy of room as well as of power is had; or the station may be away from the docks entirely. Mr. Williams also proposes to utilize the power plant for lights to facilitate work at night, and has devised some special apparatus for safely lighting the interior of the vessels while being unloaded, as well as the docks. The motor employed by the company is the single-magnet type of 30 h. p. and together with the controlling devices was designed for this special work by Mr. Frank B. Rae, of Detroit.

One great advantage of the Nicholson system is the presence on the tram-car of the operator, who is at all times over the scene of work, and has perfect control of the movements of the car. This obviates the necessity of the signal men used in the steam cable systems. The mechanical parts subject to wear and tear are reduced to a minimum in the electric hoist, and the absence of the boiler and engine plant of the steam systems occupying room valuable for storage of ore, is an important feature. The first cost of construction, the cost of maintenance and the expenditure for labor are all much less with the electric system than where steam cables are used.

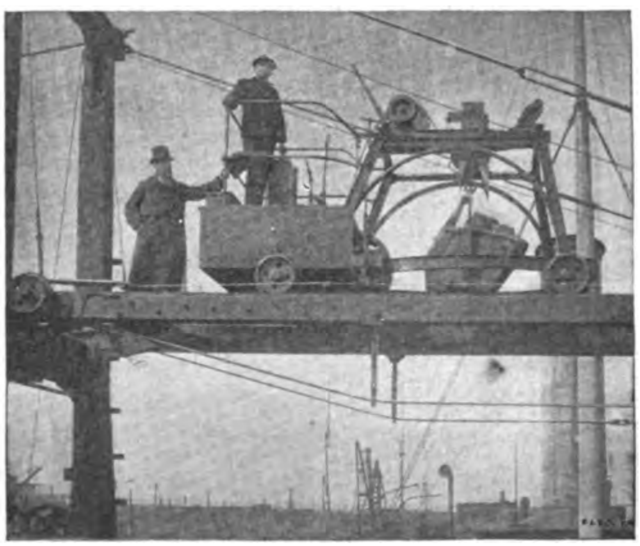


Fig. 2.—The Nicholson Electric Hoisting and Conveying Machine for Handling Freight on Docks, etc.

A few figures concerning the iron and coal interests of the great lakes may show to what a magnitude the work of loading and unloading vessels has reached on those inland waters.

During six months of navigation in 1890, nine million tons of iron ore was transported by vessels from the mines on Lake Michigan and Lake Superior to ports on Lake Erie, where it was unloaded. At Cleveland alone last year, two million tons of ore were unloaded at the docks, and one million tons of coal were shipped to the upper lake ports. In order to accomplish this amount of work, many of the docks have been equipped with steam systems of hoisting and conveying, at a great expense. The average cost of the ore tramways or "bridges" equipped is $10,000, and oftentimes six of these bridges are placed opposite one vessel for unloading.

These steam hoists only work in the day-time, while the Nicholson system is designed to work at night as well as during the day, thereby reducing the length of time necessary for vessels to remain at the discharging port. In these days of radical changes, time is the most important element to the vessels of lake marine, and with the advent of the "Whaleback" barges and steamers of greater speed and carrying capacity, the terminal companies must equip their docks with hoisting plant giving the greatest dispatch.

The Nicholson system appears to supply this want and not only will many of the docks at the lake ports recognize this and equip with electric hoisting and conveying machines, but other ports where it is desirable to unload merchandise from steamers, such as boxes, casks, bales, etc., and remove the goods to some point for storage more cheaply than by using 'longshoremen, will adopt this economical system.

The Nicholson Electric Hoist Company has been organized by Mr. Williams in Cleveland, and the directors are men largely identified with the shipping and iron mining interests of that region. Mr. C. W. Foote, formerly agent of the Sprague and Thomson-Houston Companies at Cleveland, is the general manager of the company. The mechanical work and bridges will be constructed by the Cleveland Ship Building Company, while the electrical equipment will for some time to come be purchased in the open market.

COMPENSATING RESISTANCES FOR GALVANOMETER SHUNTS.

BY

Charles P. Frey

The ordinary operation of connecting a resistance commonly called a shunt in multiple with the coils of a galvanometer, and thereby decreasing the current flowing through the instrument, and consequently confining the swing of the needle to an observable range, is too well known to require description. In order to reduce the deflections to known proportions, it is necessary to use coils in both galvanometer and shunt, the resistances of which have an ascertained value. Briefly, the formula for shunts is as follows: If the total current (C) divides between two resistances, the lesser resistance will carry the greater current and vice versa. The proportion of current traveling through the galvanometer will be $C\frac{S}{G+S}$, and the current flowing through the shunt will be $C\frac{G}{G+S}$.

For convenience in calculation, the resistances of shunt coils are usually proportionately adjusted so as to reduce the galvanometric sensitiveness to its $\frac{1}{10}$, $\frac{1}{100}$ and $\frac{1}{1000}$ part.

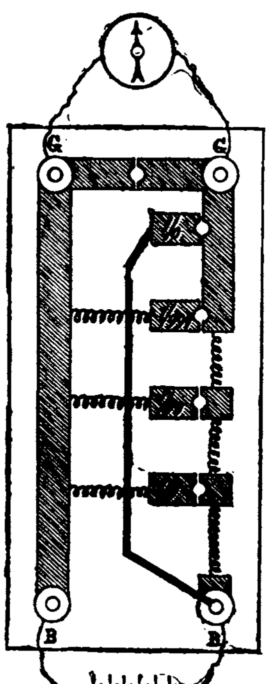
Shunt coils form an important adjunct to a galvanometer, especially when the latter is of the reflecting type, and is to be employed in connection with other apparatus for determining the value of high resistances. When the conditions of lines or the insulating qualities of materials used for covering wires are to be tested, shunts are almost indispensable. In high-resistance measurements, the usual method of employing shunts is to determine the "constant" of a galvanometer by means of the $\frac{1}{1000}$ shunt, and noting the deflection.

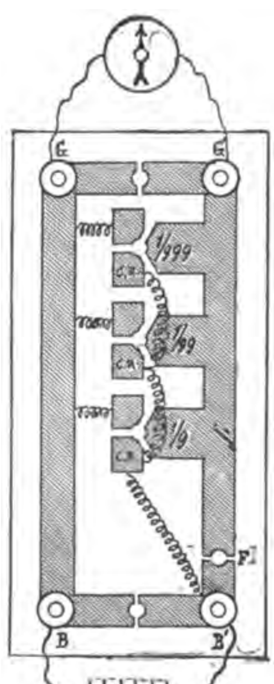
The "constant" once determined, the insulation of the line, etc., is generally measured by cutting out the shunt and any resistance that may have been introduced in the circuit, and taking readings with the galvanometer at maximum sensitiveness. An error in the degree of deflection obtained when the shunt is used will hence introduce an error in the basis for calculation. It is therefore evident that it is of intrinsic importance to secure shunts upon the correct adjustment of which dependence can be placed. When purchased from reliable manufacturers, there is usually no cause for apprehension on this score, but nevertheless there is a source of error involved in the use of ordinary shunt coils which, as one writer has it, "introduces an element of vagueness in the result." The fact is, a shunt having a resistance of, for instance, exactly $\frac{1}{9}$ the resistance of the galvanometer, will *not* reduce the deflection to precisely $\frac{1}{10}$, although the formula previously referred to seems to proclaim that such will be the case.

Disproportionate deflections are sometimes correctly attributed to lack of proper adjustment in the position of the scale. Obviously it is essential to adjust the scale so that it will be perpendicular to the reflected beam when the latter is not moving, but even this precaution will not eliminate the discrepancy.

Several prominent writers on the subject of electrical "testing," among others, Sprague, Ayrton, Gordon and Kempe, have mentioned the peculiar characteristic of shunts referred to, but only one author (Kempe, as far as the writer of this article can discover) has treated the subject exhaustively. In his excellent handbook on Testing, Kempe explains as follows :

. . . . "When a shunt is introduced between the terminals of a galvanometer which reduces its sensitiveness to one-half, or a shunt equal to the resistance of the galvanometer, it will not exactly halve the current passing through the instrument. If we used a tangent galvanometer, we would find, if the deflection without the shunt was 40 divisions on the tangent scale, the introduction of the shunt would not bring the deflection down to 20, but some deflection greater than 20. The reason of this is that the introduction of the shunt reduces the total resistance in the battery circuit, and consequently increases the strength of the current passing out of the battery. It is this increased current, then, which splits between the galvanometer and shunt, and not the original current. To make up for this decreased resistance caused by the introduction of the shunt, it is necessary to add in the battery-circuit a *compensating resistance* equal in value to the amount by which the original resistance was reduced."





KEMPE'S ARRANGEMENT. FREY'S ARRANGEMENT.

FIGS. 1 AND 2.—COMPENSATING SHUNTS.

In addition to the above extract, Kempe devotes several pages of his work to mathematical considerations of the subject, and also describes and illustrates a compensating shunt-box of his own invention, a highly ingenious contrivance, which will be explained in this article.

The value of a compensating resistance (if introduced in the battery-circuit) must, in order to maintain a uniform current, be equivalent to the difference between the resistance of galvanometer and shunt in multiple, and that of the galvanometer only. When the resistance of the galvanometer is, for instance, 5494.5 ohms, and its sensitiveness is to be reduced to its $\frac{1}{10}$ part, the value of the shunt will be $5494.5 \times \frac{1}{10-1} = 610.5.$

The resistance of the divided circuit (galv. and shunt) will be $\frac{G\,S}{G+S} = 549.45.$ The compensating resistance will be

$$5494.5 \times \frac{10-1}{10} = 4945.05$$

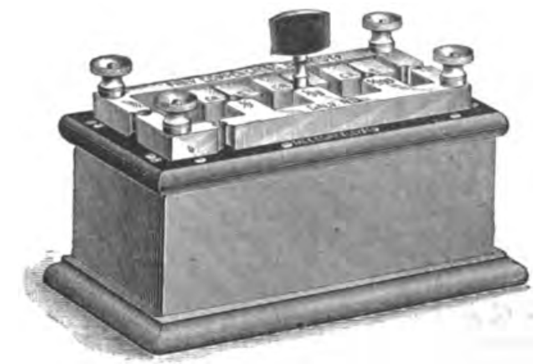


FIG. 3.—FREY COMPENSATING SHUNT.

Or, the compensating resistance (C) may be determined as follows : $C = G - \frac{G\,S}{G+S}$. In simple arithmetic the compensator equals, in this case, $5494.5 - 549.45 = 4945.05$. Kempe's device for combining shunts and compensating resistance so that both may be thrown in circuit by means of one plug, is illustrated by Fig. 1. By following the path of the connections it will be seen that by placing a plug in the hole marked $\frac{1}{2}$ the shunt is cut out. Now removing the plug to the $\frac{1}{1000}$ position will throw in circuit a shunt equal to $\frac{1}{999}$ of G and also introduce in the battery circuit a compensator consisting of three branches connected together in series, which jointly equal $\frac{999}{1000}$ of G.

Placing the plug in the $\frac{1}{10}$ position will, however, necessitate a change in the ratio of the corresponding shunt coil, since that part of the compensating coil which is between the $\frac{1}{10}$ and $\frac{1}{100}$ contact blocks, is now added to the *galvanometer circuit*. Hence this resistance becomes an inconvenient factor which must be taken into consideration in determining the value of the $\frac{1}{10}$ shunt. When the $\frac{1}{2}$ shunt is to be used, matters are still further complicated, as will be seen by referring to the diagram. The formula for determining the value of shunts and compensators of this type may be found in Kempe's treatise. The instrument itself has not however come into general use, owing probably to the intricate adjustment required, and the difficulty involved in testing the various requisite resistances. Figs. 2 and 3 illustrate a shunt box with compensating resistances which (the writer believes) embodies all of the essential features of Kempe's arrangement without the attendant complications already referred to. Its construction is exceedingly simple, and can be at once understood by tracing the path of connections on Fig. 2. It consists primarily of three shunt coils of usual proportionate resistances. These can be successively thrown in circuit together with suitable compensating coils, by means of a single plug, which, when inserted, connects in each case two independent blocks with a common conductor. The battery wires are connected at B and B' as shown and the galvanometer at G and G'. Now if one of the shunt coils is in use and an extra plug (not required for actual tests) be inserted at F, the compensating coils will be short-circuited, and since the principle of adjusting the shunt coils to $\frac{1}{10}$, $\frac{1}{100}$, and $\frac{1}{1000}$ (or any other preferred fraction) of the galvanometric resistance is maintained throughout, the box will not, under the given conditions, differ from one of conventional pattern as far as the shunt coils are concerned. When, however, the extra plug at F is removed, the path of the current from the battery will be from the insulated block at B' *through the compensating resistance* to the nearest block marked $C\ R$. If the plug is inserted at $\frac{1}{10}$, the current will then split between the $\frac{1}{10}$ shunt and galvanometer coil. Between the first block $C\ R$ and the second is another compensator connected in series with the first one, and between the second and last block is a third coil connected in series with the two others.

Since each block will be insulated when unplugged, the wire used for the $\frac{1}{10}$ compensator may form part of the compensator for the $\frac{1}{100}$, etc.

The resistance of the three parts of the compensating coils is determined as follows: Let G (the galvanometric resistance) be 5494.5 ohms. The $\frac{1}{10}$ shunt compensator will then be 4945.05 ohms (see preceding formula). The total resistance of the $\frac{1}{100}$ compensator will be 5439.555; but since part of this resistance is furnished by the $\frac{1}{10}$ compensator, the resistance of the coil between the first and second blocks marked $C\ R$ will be $5439.555 - 4945.05 = 494.505$, while the resistance between the second and third block marked $C\ R$ will be: $5489.0055 - 5439.555 = 49.4505$. Hence it is obvious that the resistance of the entire circuit will remain uniform, whether shunt coils are used or not. When it is desired to use the galvanometer at maximum sensitiveness, the plug is removed from the shunt coils and inserted at F. This simultaneously cuts out both shunt and compensating resistance and permits the current to travel directly to the galvanometer, through the brass bars.

Removing the plug entirely leaves the circuit open. To short circuit the battery and leave the galvanometer open, the plug is placed between B and B' and finally when experiments are concluded, the galvanometer can be short circuited and the battery circuit left open by placing the plug between G and G'.

In addition to general ease of manipulation, this form of compensating shunt has the advantage of being easily and quickly tested for accuracy with the aid of a rheostat and bridge. The resistances of the shunts only can of course be tested by connecting G and G' and shifting the plug. By connecting at B' and G' the compensating coils can be measured in the same manner.

Greeley Laboratory, Greenbush, N. Y.

THE POLESCHKO TRANSFORMER.

All existing transformers may be classed in two groups; in the one, such as the Ruhmkorff coil, the Gaulard & Gibbs and the Swinburne "hedgehog" transformer, the iron core is in the form of a cylinder; in the other the iron core is in the form of a closed geometrical figure, annular as in the Zipernowski, Deri and Blathy, or otherwise, as in the Westinghouse, Ferranti, &c. In transformers of the first group, the lines of force generated in the iron core by the action of the primary helix are given off as a bundle from the north pole and proceed to the south pole across the outer space, where they form closed curves of all possible radii. The secondary coil in this case is in the intermediate space between the iron core and the exterior system of the lines of force. In transformers of the second group, all the lines of force generated in the iron core by the action of the primary coil remain entirely in the core itself without appearing at the exterior. These lines of force remaining in the iron core can only pass in the interior of the spirals of the secondary coil or they may encircle the outer secondary coil. In both cases the lines of force never touch the secondary helix itself.

In transformers of the first group, as well as the other, the secondary coil is not traversed by all the lines of force which circulate in the iron. It is only a small portion of the lines of force which detach themselves, so to speak, from the general magnetic flow which reaches the secondary coil in closing along short elementary curves.

Recently however, Mr. Arcadius Poleschko, of St. Petersburg, Russia, has devised an arrangement, shown in the accompanying illustrations, by which the magnetic

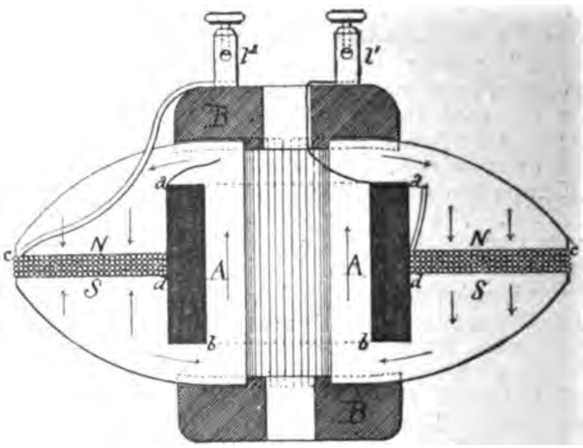


Fig. 1.—The Poleschko Transformer.

flux in the iron is all made to pass entirely across the secondary coil. In this apparatus the secondary helix $\pm l_2 \mp l_2$ is influenced in the first place by the current in the primary helix $\pm l_1 \mp l_1$, and in addition by the whole of the magnetic flux which is developed in the iron core A A by the action of the primary coil upon this core.

The core consists of blades or thin plates of sheet iron. The plates A A, the shape of which is shown in Fig. 1, are arranged in the form of a ring and inserted at the top and bottom into two insulating hubs B B. The primary coil $\pm l_1 \mp l_1$ is arranged in the vertical cavity *ab* within the interior of the core, Fig. 1, and the secondary coil $\pm l_2 \mp l_2$ is arranged outside the first in the form of a flat ring of small height, but of great breadth, in the direction of the diameter of the ring. The secondary coil of this shape is placed in a narrow channel *cd* in the core, extending substantially at right angles to the slot *ab*. The ends of the two coils are led to corresponding terminals on the insulating hub.

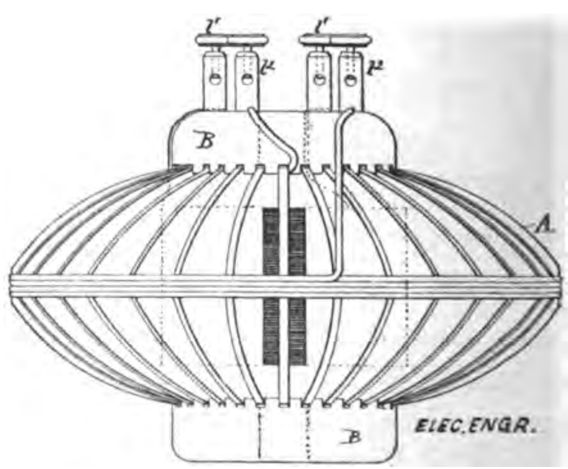


Fig. 2.—The Poleschko Transformer.

The channel which cuts the mass of the core across the direction of the lines of magnetic force increases very considerably the rapidity of demagnetization and diminishes the hysteresis. The thin iron plates of the core are insulated one from another by air. This arrangement of core has the double advantage of avoiding Foucault currents and of increasing the cooling surface.

THE ELECTRICAL USES OF EUREKA TEMPERED COPPER.

Among the numerous improvements in detail which have aided in raising the electrical arts to their present high standard, those relating to the manipulation of cop-

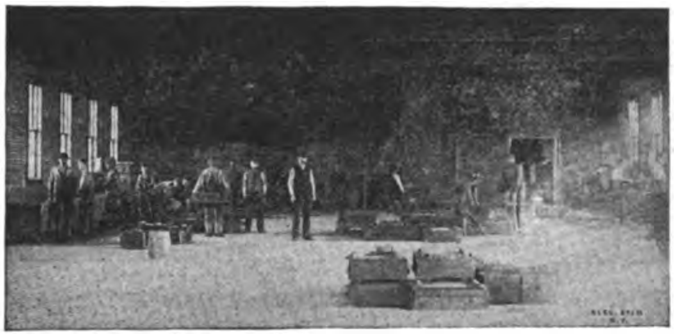


Fig. 1.—Moulding Room, Eureka Tempered Copper Co.'s Factory, North East, Pa.

per itself may well claim a prominent position. As copper in its various forms constitutes a vital material of all electrical apparatus, and especially that of dynamo-electric machinery, a process by which its life could be prolonged was, therefore, a problem, the solution of which might well occupy the time of investigators. It was already known that copper had been tempered by the ancients, as borne witness to by specimens of copper edge-tools in many museums; but the tempering of copper was a lost art, until within a few years, when Mr. Almer Thomas discovered the process as the result of a prolonged attempt to overcome a seemingly insurmountable difficulty. The history of the discovery is well worth recording here. It would seem that trouble with a wrist-pin box in the oil regions of Pennsylvania, while drilling an oil well, led

Fig. 2.—"Gate" Room.

him to experiment with all the remedies and mixtures of metal, and, finding none that would keep cool where he had to use the box, he tried copper, but with no better results. He then, with true Yankee grit, determined to try a scheme of making the box do the work and, after days of patient labor, he succeeded.

From this successful start many annoying wrist-pins in all the surrounding country were repaired and engineers felt that their days of trouble were fast disappearing. Mr. Thomas had in effect discovered, first, a method of casting pure copper without alloys of any kind and free from blow-holes; and, second, a method by which the copper so cast could be hardened sufficiently for all mechanical uses and imparted a strength equal to that of ordinary steel, or, if desired, made as malleable as wrought-iron and capable of being welded or forged into any desired shape by any blacksmith.

The marvelous success met with at once enlisted the attention of capitalists, and the Hon. W. L. Scott and Messrs. Alfred Short and Luzern Merket were associated with Mr. Thomas in the advancement of the new art. This resulted in the formation of the Eureka Tempered Copper Co.

Mr. Alfred Short, who has been a conspicuous figure in all enterprises of a mechanical nature in North East, Pa., was made president and general manager of the company, and in less than two years the company was enabled to construct a building devoted entirely to its own uses. This building is constructed of brick with slate roof, a model in design, furnishing free ventilation, and the moulding-room, shown in the engraving, Fig. 1, is 150 feet by 50 feet and 16 feet in the clear, being probably without ex-

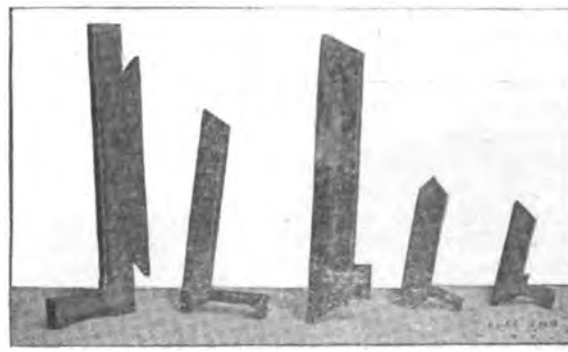


Fig. 3.—Various Forms of Commutator Segments.

ception the largest copper foundry in the world. It is designed to accommodate 12 massive copper furnaces.

The gate-room, Fig. 2, adjoins the moulding-room, where are located many workmen cutting off gates and grinding the surplus from castings. The gate-room was formerly the old moulding-room and is 50 feet by 50 feet.

With a material of this character at their command, and knowing the difficulties encountered with commutators and brushes, it is not to be wondered at that the company devoted the first eighteen months of their existence entirely to the manufacture of commutator segments and brushes.

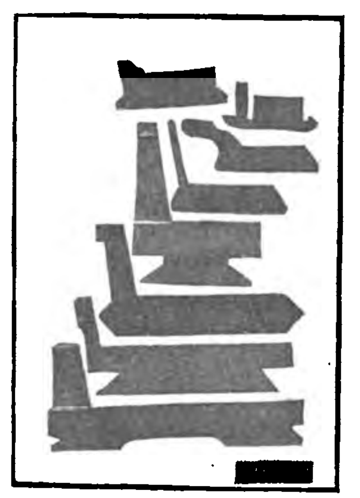


Fig. 4.—Various Forms of Commutator Segments.

For, in spite of the many attempts which have been made to supersede the employment of copper subjected to wear in electrical apparatus, the fact remains that at the present time, no substitute is available which can be said to compare with copper for such purposes. This quest for a substitute was early inaugurated in the present electrical era, and as a result we may note the employment at various times of commutator bars of brass and various alloys, and, in one instance even, of iron, but they all lack the essential qualities of conductivity and toughness which copper alone possesses, and which is brought out in a marked degree in the tempered copper manufactured by the Eureka Tempered Copper Company. This metal combines those peculiar qualities which enable the commutator bar to withstand the peculiar action to which all surfaces transmitting heavy electric currents are subjected. This quality, once pointed out, was quickly appreciated by the manufacturers of electrical apparatus with the result that at present scarcely a single part of electrical machinery subject to rubbing contact and wear is now employed in which the Eureka tempered copper is not in use. Thus, in the accompanying engraving Fig. 3, are illustrated a variety of commutator segments employed in various types of machines which in themselves form an interesting study of methods of construction of this particular and important part of all direct current dynamos. Still other forms of commutator

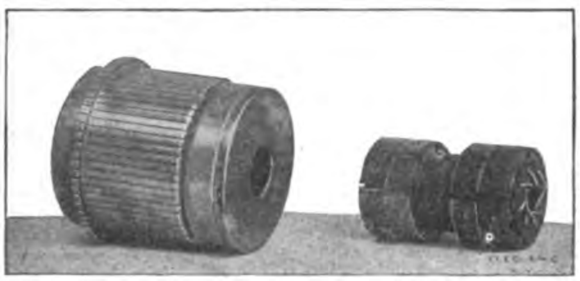


Fig. 5.—Low and High Potential Commutator.

segments are shown in Fig. 4, each having its peculiar individuality. Fig. 5 shows two well-known types of commutators, that to the left being the usual type employed with the Gramme and Siemens type of armature; and that to the right, a Brush commutator.

But there are still other important surfaces subject to wear on the dynamo, namely, the brushes, and in this direction, also, the Eureka Company has applied its metal with eminent success. Fig. 6 shows the various types of brushes, from those with fine slits up to the type embodying almost a solid construction, adapted to various types of machines. These brushes partake of the same nature as the commutator segments in their wearing qualities, in toughness, as well as in their conductivity, and, as a con-

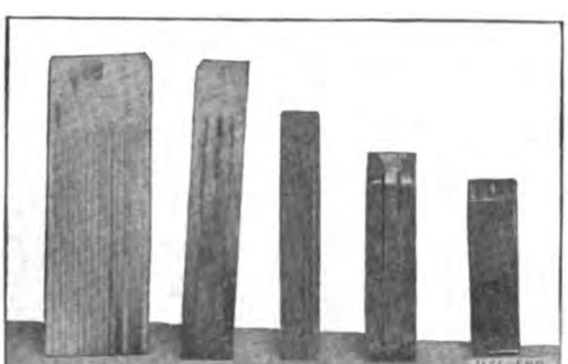


Fig. 6.—Types of Tempered Copper Brushes.

sequence, where both are used the sparking at the commutator is reduced to a minimum.

The large wear met with in some of the practical details of electric railway work has also developed several important applications for tempered copper there. Among these we may mention its employment in the gears employed to transmit the power from the motor to the car axle, and also for trolley wheels to take the current from the overhead wire, examples of which are shown in Fig. 7. In the case of the gear wheel, its peculiar toughness gives it not only a long life, but the anomalous structure of tempered copper largely reduces the noise, which is so noticeable and disagreeable a feature in steel pinions. In the case of

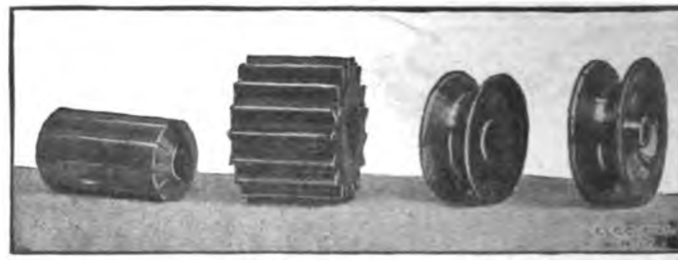


Fig. 7.—Railway Gears and Trolley Wheels, Tempered Copper.

the Eureka tempered copper trolley wheels, its wearing qualities have also largely reduced the difficulties encountered by this necessary adjunct to electric railway work. That important *vade mecum* of the electrical worker, the soldering iron, has also brought out the admirable qualities of tempered copper, and our illustration, Fig. 8, shows two forms of such soldering irons, which are very little liable to "burn." This illustration also shows a segment of a Thomson-Houston commutator, for which this copper has been largely employed.

Numerous tests have shown tempered copper to consist

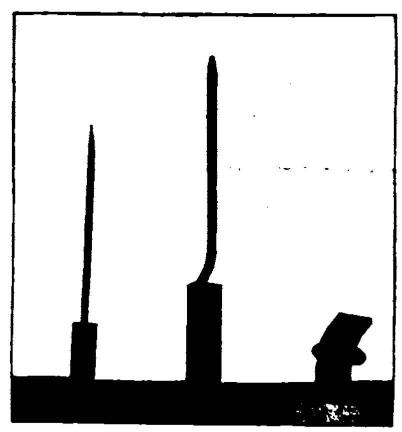


Fig. 8.—Tempered Copper Soldering Tools.

of copper 99.981 per cent. pure, with a tensile strength of 64,000 lbs. per square inch and a compression strength of 189,000 lbs. to the square inch. A test made a short while ago by the Austrian Government Industrial Department at Vienna, showed a higher tensile strength than many of the steels which had been tested there.

Wire made from tempered copper is being largely used for all purposes where great strength is desired, and its purity renders its conductivity far greater than copper alloys. Besides this, its fibrous nature makes it an excellent metal for bearings, to which purpose it is now being largely applied.

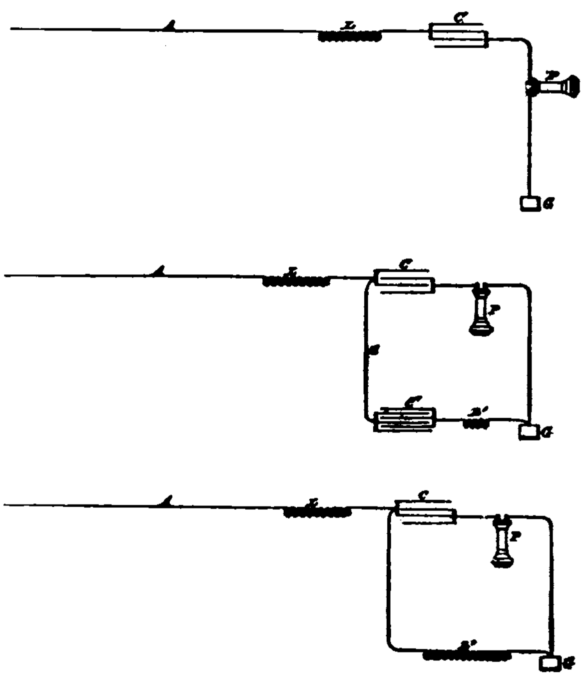
We may note here also that in recognition of the remarkable and valuable properties of Eureka tempered copper, the company has been awarded the John Scott Medal of the Franklin Institute.

Besides the shops illustrated, the works of the company embrace a large store and packing room. The products here assembled include everything made of copper, from the smallest contact buttons or spiral springs, to bearings weighing half a ton each. The machine shop and pattern-room are also extensive and all buildings are equipped with machinery of most modern construction and latest improvement.

The situation on the line of the Lake Shore Railroad, and the New York, Chicago and St. Louis Railroad, with branch tracks running into the works, gives them unexcelled shipping facilities. Each department of the immense works is under the direct charge of a foreman of thorough training and experience, and only skilled workmen find employment in the works. With these advantages the company are enabled to produce the best quality of work, which is attested by the fact that there is scarcely an electrical manufacturing concern in the country that does not use tempered copper in one form or another. The growth and success of this important enterprise is a most striking instance of the manner in which electricity stimulates work in other fields; and the subject has seemed to us specially worthy of extended treatment in our columns.

STANLEY AND KELLY'S INDUCTION PREVENTER FOR TELEPHONE LINES.

It is a well-known fact that the self-induction and capacity of an electric circuit over which a current of a given periodicity is flowing may be adjusted relatively to



Figs. 1, 2 and 3.—Stanley & Kelly's Telephone Induction Killer.

each other and to the current so that only the dead resistance of the circuit will be opposed to the passage of such current. In general, if n be used to denote the number of complete waves of the current per second, L, the coefficient of self-induction of the circuit, and M, its capacity in microfarads, then any line that possesses the necessary values of L and M in the equation

$$n = \frac{10^3}{2\pi\sqrt{LM}}$$

will offer no other opposition to a current of n waves than that of ohmic resistance. It is obvious, however, that for all other frequencies an opposition other than that of ohmic resistance will appear, for higher frequencies, due to an unbalanced self-induction, for lower, to an unbalanced capacity. It is clear, moreover, that as the capacity introduced continues to neutralize the self-induction to some extent for all frequencies, that all rates above the normal will get through more readily than if no capacity were present, although the farther they are from the normal the less will they be helped. It is otherwise with lower frequencies. Here the opposition is due to the capacity, the new element introduced into the circuit, and for rates a certain amount below the normal, the opposition offered by the unbalanced condenser is greater than that previously afforded by the self-induction alone.

In applying this principle to preventing interference due to induction on telephone circuits, Messrs. William Stanley, Jr., of Pittsfield, Mass., and John F. Kelly, of this city, have recently devised the method illustrated in the accompanying engravings. In Fig. 1, A is a telephone line grounded at G, and P a receiver. In order to oppose disturbing currents, a self-induction coil L and a condenser, C are introduced into the circuit between the receiver and the line.

The relative values of these devices are readily adjusted by varying the length of the coil and the size of the condenser, so as to hinder to a very great extent the propagation of waves of a frequency below a predetermined limit, while favoring those producing speech.

In Fig. 2 this arrangement is modified by the addition of a shunt S from line to ground around the condenser and the receiver, which is so adjusted as to capacity and self-induction by means of a condenser C' of comparatively large capacity and a self-induction coil L of comparatively low self-induction so as to possess a high degree of receptivity for long waves. In Fig. 3 is shown a similar arrangement, except that the shunt S is arranged to have a high self-induction and low resistance, which would tend to shunt the long waves and oppose the short.

ELECTROMOTIVE FORCE, WITH SPECIAL REFERENCE TO THE EXTENSION OF OHM'S LAW.—I.

BY

Maurice Oudin, M.S.

A celebrated physicist has said that science alone has the claim to be called such, whose laws can be expressed by mathematical relations. Such are the sciences of mechanics, heat, light, sound, electricity and magnetism; in fact, all the physical sciences save chemistry, and even the last is approaching that state where it will be included in the list. Actual measurement, involving the application of numerics is the only means we possess of verifying mathematical laws. Newton was ready to abandon his grand hypothesis of the law of universal gravitation, because an error was made in measuring a degree upon which he had based his computations. The idea of potential long remained a mathematical abstraction. It was only when applied by Green to the calculation of electrical forces that its true use and significance were recognized. The truth of the mathematical statement that the inside of a hollow sphere is free from electrification was not verified until Michael Faraday built his experimental cage. Without the ability to express the proper relations of facts and to interpret those relations, our knowledge can at the most be meagre and uncertain.

The simplest and best-known law in electrical science is that enunciated by George Simon Ohm. The result of his mathematical speculations on the transmission of electricity through a conductor was first published in Poggendorf's Annalen in 1825. The essay afterwards appeared in book form in 1827, and was translated into English by Dr. Francis in the year 1841. It has been a matter of frequent comment that the great men of Germany have not always received due recognition and in many cases have gained their reputation late in life. It is difficult for us to understand the marked disapproval and even bitterness with which Ohms' work was received. His theory was utterly discredited and then ignored. Indeed Faraday was unfamiliar with the law of Ohm, and Henry likewise was ignorant of its existence although in dealing with electric currents he had intuitively recognized the principles involved. Two decades ago the vague terms intensity and quantity, were the usual means of indicating currents of high and low electromotive force.

This same uncertainty was attached to the phenomena of electrical science generally. There was no system of absolute measurement in general use until after the exhaustive work of the British Association on electrical standards, nearly 30 years ago. And this notwithstanding that the theory of electricity had almost reached its present state of development. Henry took the intensity of the shock experienced from a current of electricity as an indication of its strength, and earlier in the history of the science the distance to which a pith ball was repelled and the jumping distance in air of a spark were also means of indicating magnitude of electrical phenomena. Even after the general introduction of standard instruments into our lecture-rooms the greatest ignorance regarding their constants prevailed for a long time.

The application of Ohm's law helped to bring order out of this chaotic uncertainty. Only the necessities of practice, however, caused it to be dragged out of the waste heap. The successful application of its principles in telegraphy called the attention of scientific men to this law, the simplest in electrical science and of an importance the most truly immense.

Of the three fundamental quantities of a galvanic circuit, electromotive force is the most important. That quality called resistance is entirely dependent upon the specific nature of the substance of which the conductor is composed. A current is the result of an E. M. F. acting at the time or previously. Electricity in the sense of quantity of electrical separation has invariably associated with it an E. M. F., just as heat involves the idea of temperature or a suspended weight that of gravity. An E. M. F. can exist without the presence of the other two constants. The terminals of a voltaic cell and of an open coil moving near a magnet offer examples of the presence of an E. M. F. unaccompanied by a continuous current. It is not within the scope of this paper to view the practical side of the subject, nor to indicate the relation of the galvanic quantities to other electrical quantities. I shall confine myself to an exposition of the sources and manifestations of electricity in motion, dwelling more particularly upon the theory of E. M. F. as it is the chief factor in the modification of Ohm's law.

When a Leyden jar is discharged through a circuit, or a current from any source is maintained in a wire we say there is a transfer of electricity from a point at a certain potential to one at a lower potential. The property of producing this difference of potential in virtue of which electricity is set in motion, is ascribed to a cause called electromotive force. It is not a force at all as we understand the meaning of force as used in mechanics. The word is here used by analogy only; there is no identity whatever. Just as a force must be applied to lift a weight a certain height (a point of higher potential with respect to its original position), so by analogy, when there occurs an electrical separation, as at the electrodes of a battery, we call that producing it an E. M. F. In the mechanical illustration, if the support be removed the weight will fall to a gravitational plane of lower potential. Join the terminals of the battery and a current will flow from the positive or point of higher potential, to the negative or point of lower potential.

It is important that the distinction between E. M. F. and difference of potential should be clearly made, as there exists much confusion with regard to the proper use of these terms. In a circuit in which a source of E. M. F. is localized, there is between any two points a difference of potential. The line integral of the fall of potential measures the E. M. F. There can be no D. P. without a previous E. M. F., but we may have the latter without the former. As for instance when a cylindrical magnet is suddenly introduced into a coil of wire. An E. M. F. is set up in the wire, yet every point in the circuit is at the same potential. The same is true when an annular vessel filled with water is made to rotate in its plane. A motion of the liquid ensues although there is no difference of level. Analogies are useful, and to further illustrate my point, conceive a pump raising water to a height, say, of 20 feet. Here in a crude way the force actuating the pump corresponds to E. M. F., and the new elevation of the water with respect to its original level to D. P. Remove the E. M. F. and in consequence of the D. P. a current flows. In short, we may say, E. M. F. produces a D. P., and is measured by it.

The relation of E. M. F. and energy is a close one, indeed E. M. F. may be said to be absolutely inseparable from the idea of energy. Although, as we have seen, an E. M. F. may exist without an actual flow of electricity it requires for its excitation an expenditure of energy, and produces what we may call an electrical displacement. The work done in the deflection of an electrometer needle, under the influence of electrostatic forces against the torsion of a wire, proves this by Joule's famous principle of the conservation of energy. The amount of work involved is necessarily small. It would require instruments of great precision and refinement to determine the difference of work required to suddenly insert a magnet and a soft iron bar into an open circuited coil. The moment the circuit is closed, however, and the magnet thrust in, a current flows and then the force necessary for the operation is considerable. In electrostatics, difference of potential is measured by work done. Two pith balls of opposite and equal charges cannot be separated without a change in the energy of the system, the amount of which is represented by the equation—

$$\text{Energy} = m\left(\frac{1}{r} - \frac{1}{R}\right)$$

where m is the total electrification or quantity of electricity, and r and R are the original and final distances separating the pith balls. In its final state the energy of the above system is at a maximum and wholly potential. If left to itself it speedily falls to a minimum, the potential energy becoming kinetic in the process.

The change from one condition to the other always manifests the presence of a force. It is only when a change of energy of one form into another occurs or tends to occur that we are aware of the existence of an E. M. F. In the case of the pith balls it will be observed that there is a transfer of electricity against the attracting forces. The work done on the system is $M. V$, the product of the quantity of electricity into the difference of potential. Such a transfer of electricity is analogous to a current; it is identical in its effects, as Prof. Rowland and others have shown, when the transfer is made with the velocity of light, which is the rate of transmission of an electric impulse along a conductor. All generators of electricity are transformers of energy, the dynamo transforms energy of mechanical motion into electrical energy, the battery that of chemical affinity, and the thermopile that of heat into electrical energy. The resulting current is a manifestation of some kind of motion. It is evidence of a transfer of energy. The E. M. F. at the terminals of a generator is a measure of the urging or tendency of the generator to transform mechanical, chemical or heat energy into electrical energy. The product of these two quantities, current and E. M. F. gives the total energy or activity of the circuit.

There are two ways of viewing the manner in which an E. M. F. gives rise to a current. We may regard the E. M. F. as a force applied, either at the ends of the conductor, like the pressure of a pump drawing water through a pipe, or literally throughout the whole extent of the conductor like the vanes of a paddle-wheel. The outcome of recent experiments seem to show that the last view is the correct one. Oersted's discovery of the disturbing influence upon a compass needle by a current, as shown by Faraday, indicated the existence of a medium that transmitted electrical stresses. The mathematical treatment was undertaken by Maxwell. The results were found to be in strict accordance with Faraday's experiments. It remained for Hertz of Bonn to prove, as far as experiment can prove, the existence of a medium, and to confirm Maxwell's theory that the medium in which electrical stresses are propagated is identical with the light-transmitting medium—the ether. It is here we must abandon hydrostatic analogy, for there is no external disturbance to indicate a flow of water through a pipe. Conducting bodies are regarded as breaks in the ether, offering an easy passage to a flow of electricity. The battery, dynamo, or other generator is conceived as placing the surrounding medium under a strain. The stress thus produced is propagated along the line of least resistance, viz., the conductor, and in consequence there follows that action called electrical current. The medium plays the principal role, the function of the conductor being to determine the direction in the medium in which the transfer of electrical energy shall take place.

To Galvani is due the discovery of a new electrical manifestation; but the scientific mind of Volta developed the immense possibilities of an uncertain phenomenon. With the invention of the voltaic cell that branch of electrical science which deals with the phenomena of current flow had its beginning. For over half a century the voltaic cell was the only means of evoking large currents of electricity. Although for almost all practical purposes it has been replaced by the dynamo, its great historic interest, and especially the uncertainty attached to the theory of its action, claim for it a prominent place. In Volta's time the question as to the seat of the E. M. F. in the battery arose, and the dispute has been kept up with intermittent vigor ever since. The two great theories are the contact and the chemical. The advocates of the former claim that E. M. F. of the cell is due to the mere contact of dissimilar substances. The holders of the chemical theory formerly denied the existence of an E. M. F. not due in some way to chemical action.

Some authorities now advance a theory which is in the nature of a compromise. If a piece of copper and a piece of zinc be brought in contact, there is found to be an E. M. F. acting across the junction. If these be joined at their free ends by a substance having a chemical affinity for either metal a current is developed and maintained constant as the result of the chemical action, and at the expense of one of the metals. In other words, contact produces E. M. F. which on closed circuit gives rise to a current when some extraneous means are supplied to keep the E. M. F. constantly renewed.

Sir Humphrey Davy was the first to attempt to reconcile the two theories. Faraday noticed that the composition of the electrolyte was always altered by the passage of a current, and so attributed the flow to chemical action. Sir William Thomson brought out a paper in 1851 demonstrating the existence of an E. M. F. at a junction of two metals from the well-known phenomenon called after its first observer, the Peltier effect. By far the most elaborate experimental work in this subject was carried out by Professors Aryton and Perry in Japan. They established beyond a doubt the law that the total E. M. F. of a circuit may be reckoned by adding up the E. M. F. observed for every pair of substances in contact.

"LIKE UNTO LIKE."

The editor of one of the leading technical journals of this city, in forwarding a subscription for a friend, says: "This is a Christmas present of a mighty nice electrical journal to a mighty smart young electrician."

"MASSAGE" WITH CURRENTS OF HIGH FREQUENCY.

BY

Nikola Tesla

I TRUST that the present brief communication will not be interpreted by the readers of THE ELECTRICAL ENGINEER as an effort on my part to put myself on record as a "patent medicine" man, for a serious worker cannot despise anything more than the misuse and abuse of electricity which we have frequent occasion to witness. My remarks are elicited by the lively interest which prominent medical practitioners evince at every real advance in electrical investigation. The progress in recent years has been so great that every electrican and electrical engineer is confident that electricity will become the means of accomplishing many things that have been heretofore, with our existing knowledge, deemed impossible. No wonder then that progressive physicians also should expect to find in it a powerful tool and help in new curative processes. Since I had the honor to bring before the American Institute of Electrical Engineers some results in utilizing alternating currents of high tension, I have received many letters from noted physicians inquiring as to the physical effects of such currents of high frequency. It may be remembered that I then demonstrated that a body perfectly well insulated in air can be heated by simply connecting it with a source of rapidly alternating high potential. The heating in this case is due in all probability to the bombardment of the body by air, or possibly by some other medium, which is molecular or atomic in construction, and the presence of which has so far escaped our analysis—for according to my ideas, the true ether radiation with such frequencies as even a few millions per second must be very small. This body may be a good conductor or it may be a very poor conductor of electricity with little change in the result. The human body is, in such a case, a fine conductor, and if a person insulated in a room, or no matter where, is brought into contact with such a source of rapidly alternating high potential, the skin is heated by bombardment. It is a mere question of the dimensions and character of the apparatus to produce any degree of heating desired.

It has occurred to me whether, with such apparatus properly prepared, it would not be possible for a skilled physician, to find in it a means for the effective treatment of various types of disease. The heating will, of course, be superficial, that is, on the skin, and would result, whether the person operated on were in bed or walking around a room, whether dressed in thick clothes or whether reduced to nakedness. In fact, to put it broadly, it is conceivable that a person entirely nude at the North Pole might keep himself comfortably warm in this manner.

Without vouching for all the results, which must of course, be determined by experience and observation, I can at least warrant the fact that heating would occur by the use of this method of subjecting the human body to bombardment by alternating currents of high potential and frequency such as I have long worked with. It is only reasonable to expect that some of the novel effects will be wholly different from those obtainable with the old familiar therapeutic methods generally used. Whether they would all be beneficial or not remains to be proved.

"HOW TO MAKE INVENTIONS."

MR. E. P. THOMPSON is receiving many encomiums on his book just issued with the above title. The *Boston Transcript* says it is "almost literally worth its weight in gold." The *American Machinist* says that it is "invaluable to those who wish to make invention a business and provi le themselves with means of preparation."

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"Make-and-break"—means "make" for the man who sells that invention and "break" for the man who buys it.—Dr. Elisha Gray.

POLYPHASAL CURRENTS.

NOTWITHSTANDING the widespread attention which alternate-current motor and generator work has attracted during the last few years, the subject appears to be one which is but faintly grasped by the majority of electricians, judging from the lack of knowledge of essential principles displayed. It is therefore a subject for congratulation that there is now available a discussion of the nature of polyphasal currents, which will enable those not already familiar with the subject to obtain an excellent insight into their true nature and effects. In the course of his paper, read before the American Institute of Electrical Engineers, Dr. Pupin takes occasion to dwell at some length on the claims made by Dobrowolsky in Germany as to the superiority of his apparatus over that of Tesla, Bradley and others, in that there is no fluctuation in the strength of the field in his motors. Dr. Pupin well shows the untenable position taken by Dobrowolsky by proving the very slight difference which exists between two and three-phase types of motors in this respect. But, for those who have given close attention to the work of Mr. Tesla, this question would appear to have been settled long ago. A perusal of Mr. Tesla's work will show that he dwelt on these very points in his original paper read before the American Institute of Electrical Engineers in May, 1888, and from which we quote as follows:

> The inductive effect exerted upon the secondary coils will be mainly due to the shifting or movement of the magnetic action; but there may also be currents set up in the circuits in consequence of the variations in the intensity of the poles. However, by properly designing the generator and determining the magnetizing effect of the primary coils, the latter element may be made to disappear. The intensity of the poles being maintained constant, the action of the apparatus will be perfect, and the same result will be secured as though the shifting were effected by means of a commutator with an infinite number of bars.

This shows that for the uniform shifting no more than two phases are required, and that it is only necessary to design the generator properly in order to obtain the desired result. Dr. Pupin refers to this also in his paper, where he points out toward the end that "nearly constant rotary magnetic fields can be produced in practice by a small number of phases, probably not more than three, by properly shaping the curve of the impressed E. M. F." It may not be out of place to remark here that Mr. Tesla in his original patents has also shown multiphase generators and motors, and dwelt on these points even more directly than he did in the paper read before the Institute in 1888, and we may also quote from that paper the following significant remark:

> In transformers and in a certain class of motors the fluctuation of the poles is not of great importance, but in another class of these motors it is desirable to obtain the theoretical result.

This statement applies to the two types of motors shown by him, namely, synchronizing and torque motors respectively. Dr. Pupin correctly points out the impossibility of telling from the number of phases the amount of the fluctuation. With two or with three phases only, practically the same result is obtained as though there were an infinite number of phases, but we think that, inasmuch as a motor should in most cases possess a certain tendency to synchronism, practice will show the inadvisability of employing too great a number of phases, as in such a case the falling off in speed would result in a diminished output per weight and would disqualify the motor for many purposes. As regards polyphasal generators, it seems to us, as Dr. Pupin puts it, that a high number of phases is impracticable and their employment hardly warranted in the light of the above statements, it being evident that two or three phases are quite equal to accomplishing the desired results.

The paper read by Dr. Pupin also serves to call attention to some curious analogies between polyphasal and continuous-current generators and as such they must necessarily impart to the former qualities which have heretofore not been deemed to be inherent in them. We can only express again our gratification at the work of Dr. Pupin and re-echo the sentiment of Prof. Elihu Thomson, who presided, that the paper contains the only clear exposition published thus far of the principles which underlie the polyphasal-current systems. It is understood that Dr. Pupin will give a brief series of papers—two or three—before the Institute on this subject. With the principles thus clearly pointed out and with the advantages to be derived from the use of condensers in connection with alternate current apparatus, especially motors, the time can not be far distant when the latter will have become as familiar an object as the continuous current motor is to-day.

"KNOCKING OUT" THE BERLINER PATENT.

The picturesque misinformation that cultivated Englishmen possess about this country is strikingly exemplified in an able editorial on "the Microphone in America," appearing in the December 4 issue of the London *Electrician.* Its view of the granting of the Berliner patent is thus expressed: "It is as if one had appropriated a wrong umbrella and after wearing it out taken it back again, getting a new one in its place. You cannot do that in polite society; *but you can in the New York Patent Office.*" Our contemporary adds that "there is talk of invoking *the aid of the Legislature* to put an end to collusive and injurious "interferences.' It is a pity that our contemporary, who is usually so well informed and so sound in judgment, should be under the impression that the "New York Patent Office" allows this sort of thing, or that the matter is subject to the tender mercies of our State Legislature. It is the Chicago Board of Trade that is responsible in such cases, and these collusive interferences can only be put an end to by the "referendum" in the District of Columbia, or by a constitutional ballot in the thirteen original States of the Union. No doubt this is a roundabout way of correcting an abuse, but it has been carefully modeled after the precedent which requires that the Parliament of the British Empire shall sit in judgment on the wish of Puddlecombe-by-the-Haystack to have a street railway.

TRANSFORMERS WITH OPEN MAGNETIC CIRCUIT.

The designs which have been adopted in transformer work may be said to have kept very close to those of the dynamo in so far as the nature of the magnetic circuit is concerned, and this is probably a direct outcome of the modern conception of the magnetic circuit and its treatment analogously to the electric circuit. The reduction in magnetic reluctance effected in transformers with closed iron cores, over the older forms embodying open magnetic circuits, was immediately followed by increased output at a given frequency and by better regulating qualities. But there are not wanting those who find good qualities in the older types, notably among them being Mr. Swinburne, whose "hedgehog" type of transformer is well known to our readers. The principle advantage claimed by Mr. Swinburne is increased efficiency at light loads as compared with the closed circuit type. With the evident object of retaining this benefit, while at the same time avoiding the loss of magnetic lines met with in the straight core, Mr. Poleschko has designed the type of transformer illustrated on another page. While there has been considerable discussion on the relative merits of these two types of transformers, we still lack the authoritative figures of an impartial comparative test, and we suggest this as a subject of research.

ANNUNCIATOR AND BELL WORK.

Though probably among the oldest of the applications embodying electrical signaling devices, the methods of construction and installation in annunciator and bell work have probably undergone very few changes from those practiced twenty years ago, and "electrical bell hanger" has indeed become a term of reproach in the profession. That this term, however, does not necessarily imply an utter lack of knowledge of electrical principles or of proper appreciation of the value of good work is well brought out in the interesting paper of Mr. Charles G. Armstrong on "Improvements in Annunciator and Bell Work," read before the Brotherhood of Electrical Mechanics in Chicago. Mr. Armstrong urges in the first place the discarding, as far as possible, of the large number of batteries frequently scattered about in large buildings feeding different bell circuits, and their replacement by a properly designed dynamo-generator. He also points out the necessity of employing a better quality of wire than that represented by the venerable annunciator wire, and he prefers weatherproof for this purpose. He also advocates the use of interior conduits, and, in general, the collection of all electrical signaling apparatus at one central point and its supervision by a competent attendant. Mr. Armstrong's paper is one of the best and most practical that we have seen for a long time.

"Catch-as-Catch-Can" Executions.

An official report has now been made by Drs. McDonald and Ward on the Loppy execution, from which it appears it took ten minutes to prove to that unfortunate villain that death by electricity is instantaneous. As the *New York Times,* in an admirable article on the subject remarks: "The man was killed by sections, at odd jobs, in an off-and-on sort of fashion, 15 seconds at a time. They began to kill him at 11:54:36; at 12:05, ten minutes and 24 seconds later, they discovered 'the fact that death had occurred.' They declare furthermore that death was apparently instantaneous and painless. * * * If death was really instantaneous, it must have occurred at the first contact, and the other three were superfluous and revolting." We are glad to see the *Times* and other decent papers coming to the conclusion that this electrical execution must stop.

A Shower Bath of Currents.

The attention of medical men is likely to be arrested by the suggestive little note in our issue this week from Mr. Nikola Tesla, on some peculiar phenomena associated with the effect of rapidly alternating currents of high potential on the human body. As Mr. Tesla points out, the surface of the body can thus be heated under almost any conditions; and it would obviously be easy to direct or concentrate this effect upon any part needing treatment, and this whether the patient be even lying in bed unable to stir hand or foot. The medical profession has so intelligent an interest in the therapeutic use of electricity that we believe it will soon find employment for this novel method of application. It is curious how many side issues a new line of investigation opens up.

Transformer Calculations.

In this issue Mr. Charles Steinmetz concludes his series of articles on the Elementary Theory of the Alternating Current Transformer. The graphical study of mathematical problems largely facilitates their conception in giving to the values their relative dimensions in a tangible form, such as figures alone do not convey. As such, the work of Mr. Steinmetz will prove an interesting treatise and the results of his tests on existing apparatus bear out well the accuracy of the assumptions made by him and upon which his calculations were based.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—XX.

(*Concluded.*)

BY

Chas. Steinmetz.

THE secondary circuit is not free from self-induction either, and the secondary current C_1 must lag behind the secondary E. M. F., E_1 by an angle ω_1. The constants of the transformer were:

Cross-section of iron = 63.3 square centimetres.
Length " = 30.8 centimetres.

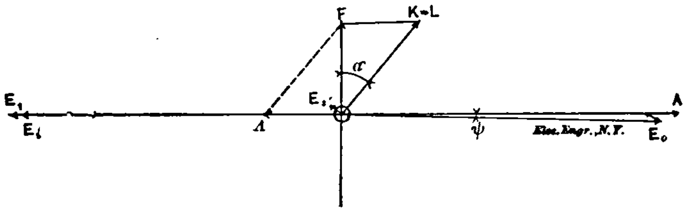


FIG. 34.

Internal resistance of secondary = .04 ohms.
" " " primary = 21.8 ohms.
Number of secondary turns n_1 = 35.
" primary " n = 675.

From these we derive the results:

	Drop of potential in secondary.	Secondary induced E. M. F.	Primary resulting E. M. F.	Primary induced E. M. F.	Secondary M. M. F.	Primary M. M. F.	Ideal M. M. F. of hysteresis.
	E_{11}	E_1	E	E_i	L_1	L	$A \quad \frac{H n_1}{E_1}$ [1]
1	.4	49.7	14	958	373	428	49.1
2	.2	50.8	8	980	204	259	57.2
3	..	51.4	4	991	44	128	63.9
4	..	53.5	3	1030	...	99	62.6

1. These values of hysteretic loss being derived as the difference of primary watts and secondary volt-amperes, must be too small for increasing secondary load, as the real secondary watts are *less* than the volt-amperes, because of the shifting of phase ω_1, caused by the self-induction of the secondary circuit.

From the value of ideal hysteretic M. M. F. for open circuit, $A = 62.6$ ampere turns, we get the angle of magnetic lag, $\sin \alpha = \frac{A}{L} = .6323$. The angle $\alpha = 39°$, and the resulting M. M. F., $F = \sqrt{L^2 - A^2} = 76.7$ ampere turns, while the direct determination of this angle, as the complementary angle to the difference of phase between primary current and secondary E. M. F., gives

WESTINGHOUSE 10 LIGHT TRANSFORMER.

Frequency, $N = 132$ complete periods per second. Secondary induced E. M. F., $E_1 = 50$ volts effective.

		Phase of primary current.	Phase of impressed primary E. M. F.	Difference of phase between primary current and impressed E. M. F.	Secondary current.	Primary current.	Secondary M. M. F.	Primary M. M. F.	E. M. F. consumed by secondary internal resistance.	Primary resulting, or heating E. M. F.	E. M. F. of self-induction in primary circuit.	E. M. F. of self-induction in secondary circuit.	Angle of secondary retardation.	Primary impressed E. M. F.
		ϕ	ψ	ω	C_1	C	L_1	L	E_{11}	E	E_s	E_{1s}	ω_1	E_0
1	Full load...	12.5°	—10.5°	23°	10.65	.647	378	437	.4	14	197	2.5	8°	1070
2	Half load...	17°	— 6.5°	23.5°	5.83	.403	204	272	.2	8	123	1.3	1.5°	1050
3	$\frac{1}{10}$ load.....	36°	— 2.5°	38.5°	1.26	.188	44	127	..	4	57	.3	.8°	1040
4	Open sec...	49°	— 1.5°	50.5°	.....	.141	...	95	..	3	43	...	....	1030

Angle of magnetic lag, $\alpha = 41°$.
Impressed M. M. F., $K = 95$ ampere turns.
Resulting M. M. F., $F = 75$ ampere turns.
Ideal M. M. F. of hysteresis, $A = 58$ ampere turns.
Secondary induced E. M. F., $E_1 = 50$ volts effective.
Primary induced E. M. F., $E_i = 964$ volts effective.
Loss of energy by hysteresis, $H = 88$ watts.

The electric quantities were found by the tests:

		Primary impressed E. M. F.	Primary current.	Secondary terminal pressure.	Secondary current.	Frequency.	Hysteretic loss.
		E_0	C	E_t	C_1	N	H[1]
1	Full load..........	1020	.634	49.3	10.65	132	69.7
2	Half load........ ...	1036	.383	50.6	5.83	132	83.1
3	$\frac{1}{10}$ load............	1021	.190	51.4	1.26	138	93.9
4	Open circuit.......	1030	.147	53.5	.....	138	95.7

$$\sin \alpha = \cos (C E_1) \frac{\text{mean } (c\, e_1)}{\sqrt{\text{mean}^2\, c \times \text{mean}^2\, e_1}} = .6514;$$

angle $\alpha = 40°$. The indirect way, by means of the diagram, gave $\alpha = 39°$, which is almost the same, though the wave of current is anything but sinusoidal.

The angle $\alpha = 40°$ gives as the ideal M. M. F. of hysteresis, $A = L \sin \alpha = 63.5$ ampere turns, against 62.6 ampere turns found directly, and the resulting M. M. F., $F = L \cos \alpha = 75.9$ ampere turns, against 76.7 ampere turns, as found before.

It is therefore evident that even in cases where the wave differs widely in shape from the sine form, the polar diagram of transformers represents the phenomenon very fairly.

If the resulting M. M. F., $F = 76$ ampere turns for open circuit, that is for the induction, $E_1 = 53.5$ volts, and the frequency, $N = 138$, for full load, that is, for $E_1 = 49.7$ volts, and $N = 132$, we derive,

$$F = 76 \times \frac{49.7}{53.5} \times \frac{138}{132} = 74 \text{ ampere turns}$$

and are now enabled to produce to polar diagram of this transformer, for open circuit and for full load in Figs. 34 and 35.

Fig. 34 gives us the self-induction of the secondary circuit, causing a shifting of phase of secondary current against secondary E. M. F. by an angle : $a_1 = 3°$, and the ideal hysteretic M. M. F. for full load, $A = 47$, against 49.1, as observed, causing an angle of magnetic lag, $\alpha = 33°$.

The E. M. F. of self-induction is derived from E_0, E_1, E, it being perpendicular to the current C. Hence,

1. $E_1 = 192$ volts for full load.
2. 116 " " half "
3. 55 " " $\frac{1}{10}$ "
4. 43 " " open circuit.

because it is proportional to the primary current and the frequency.

To compare the diagrams for different loads we reduce the electric quantities to the same magnetization and to the same frequency, by means of the law of the 1.7th power, so far as hysteresis is concerned, and otherwise by direct proportion.

Let the frequency be : $N = 132$, the secondary induced E. M. F.: $E_1 = 50$ volts. Then we derive the values given in the table, and represented in the complete diagram, Fig. 35.

It is especially interesting to notice here that, when reducing the four sets of transformer tests to the same conditions, the steady decrease of hysteretic loss for increasing load, observed by Prof. Ryan on this transformer, 95.7, 93.9, 83.1, and 69.7 watts, disappears, and the four values of hysteretic loss for different loads become 82, 85, 81 and 72 watts. The figure for full load, 72 watts, will be influenced greatly by a slight error of observation in one of the component factors, and this figure is the only one which differs much from the mean value.

Hence, *these tests cannot be used to prove a decrease of hysteretic loss*, but on the contrary, if the last figure be excluded, seem rather to indicate a *constancy and independence of the hysteretic loss from the load*, as is to be expected from theoretical reasons.

A comparison of this Westinghouse transformer with the Ganz & Co. transformer cannot well be made, because the one is a small 1 h. p. and the other a large 10 h. p. transformer, and therefore the larger transformer will give a very much more favorable diagram, as, indeed, Figs. 33 and 36 show.

These diagrams show one thing plainly; that a large transformer is much more efficient, and compounds better than a small one, and that therefore the practice of supplying each house separately by small transformers is inferior to that of supplying a whole district with a large transformer.

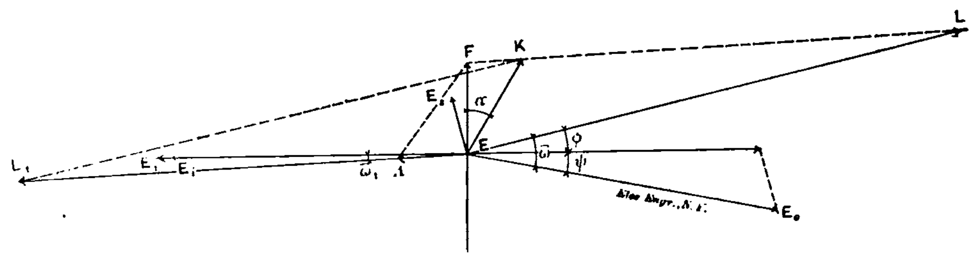


Fig. 35.

ELECTRIC CARS IN PARIS.

The Compagnie des Tramways Nord, says the *Bulletin International*, will shortly inaugurate a new service of cars between the Opera and Saint Denis. The cars will be run by electricity by means of Laurent Cély accumulators supplied by the Société pour le Travail Electrique des Métaux at a price of 4.25 cents per car mile. The route has several severe gradients; between the Rue Faubourg-Montmartre and the Rue Rochechouart the gradient is 5.5 per cent., or one in 18½. The line is nearly four miles in length. The result of this further introduction of storage cars will be watched with great interest.

A NEW THERMO-ELECTRIC BATTERY.

An ingenious little thermo-electric battery has recently been perfected which presents the following features: A small block made of a certain alloy has a small wire or a strip of nickel imbedded in it near each end; the alloy consists of antimony, three parts, and zinc, two parts. The wires project in a vertical direction from the horizontal top face of the block, and the end which is to be heated is protected from fusion by a casing made of iron. To form a battery, a number of these blocks are taken and joined in series, and they are so disposed that their cased ends can be heated to a high temperature without fusing the unprotected portions.

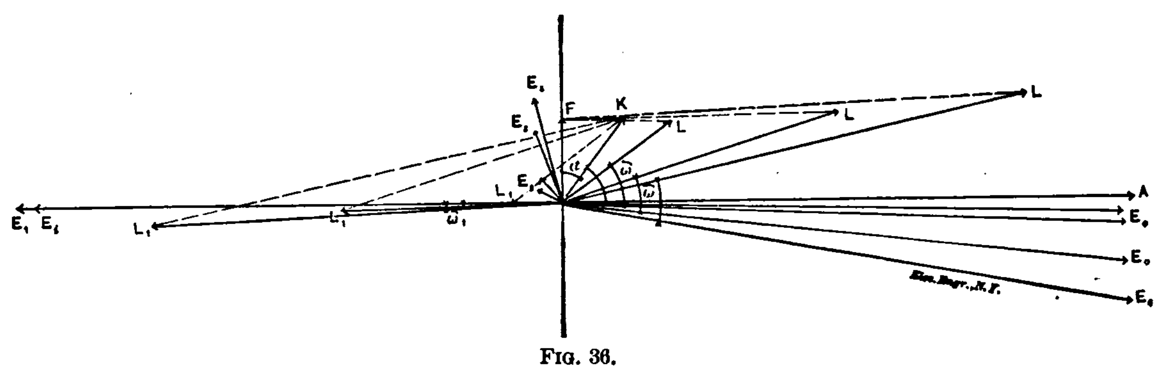


Fig. 36.

THE ATHENS, GA., ELECTRIC RAILWAY.

THE Athens Electric Railway was built by the Equitable Engineering and Construction Co., Drexel Building, Philadelphia, who took the contract for supplying the overhead electrical construction, station electrical apparatus, and electrical car equipments. This road has the McGuire trucks, and the Rae 30 h. p. electric motors. There are five cars in daily service, and five miles of track laid with 40 pound "T" rail. The power plant consists of one 80,000 watt Rae generator, driven by a Ball compound high-speed engine.

This road has been running since the middle of June and not a single cent has been spent for repairs on any part of the apparatus. The entire electrical work was done by Mr. George B. Abele, of the Equitable Co., and is one of the best pieces of electric railway work in the South. Our illustration gives a good idea of the construction and appearance of this typical Southern road. Mr. John T. Voss, manager of the road, wrote the Equitable Co. recently as follows: "The Rae motors and dynamo installed by you on our road have done all you claimed for them and have proved highly satisfactory to us. The cost of repairs is small compared with other systems which we have investigated;

THE ATHENS, GA., ELECTRIC RAILWAY.

the motors make less noise, and there is less necessity for keeping a skilled electrician in our employ than with any other system known to us, owing to the extreme simplicity of the electrical details of the machinery. If at any time you want to refer to us, we will be glad to favor you."

THE MEASUREMENT OF SMALL CURRENTS AND POTENTIAL DIFFERENCES.

THE third meeting of the Electrical Department of the Brooklyn Institute for the season was held on Friday evening, Nov. 20, 1891 in the large lecture-room of the Y. M. C. A., President Hamblet in the chair.

After the reading of the minutes of the previous meeting, the president introduced Mr. Edward H. Lyon, who gave a description of a method of measuring very feeble currents and small differences of potential of which we present the following abstract: Mr. Lyon first gave a diagram of the well-known method of La

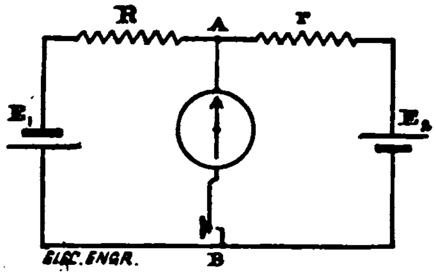


FIG. 1.—LA COINE METHOD.

Coine for comparing the electromotive force of two batteries, as shown in Fig. 1, where the battery to be measured E_2 opposes a standard battery E_1, through the galvanometer bridge A B; R being a fixed resistance of a thousand ohms or more, and r an adjustable resistance, such as a rheostat, which is varied until no deflection is obtained on the galvanometer, when $E_1 : E_2 :: R : r$. The battery resistance need not be considered unless very high.

The Poggendorff method was then shown in Fig. 2. In this method a standard battery and galvanometer are shunted around a known resistance forming part of the circuit in which is placed the battery to be measured, the position of the contact B being varied until a balance is obtained.

Mr. Lyon stated that in the manufacture of instruments for the measurement of the heavy currents and high potentials dealt with in central station practice considerable perfection had been attained, but there was no satisfactory instrument on the market for the measurement of small differences of E. M. F. and current, which was portable and at the same time sensitive and accurate.

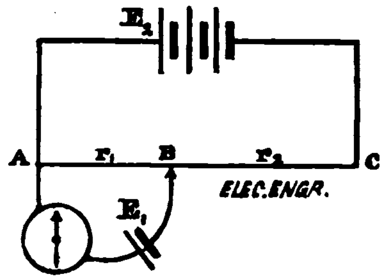


FIG. 2.—POGGENDORFF METHOD.

The instrument described by Mr. Lyon possessed both of these qualifications, and consisted of the combination of the La Coine and Poggendorff methods with a Wheatstone bridge, galvanometer and small cell of dry battery, the whole being placed in a compact carrying case.

If it were necessary to measure a battery having an E. M. F. of 1.002 volt or current of .041 ampere, this method insured the accuracy of the third place of decimals. It was not generally known that a dry battery which was worthless for many commercial purposes made an excellent standard cell if closed for short intervals only through a thousand ohms or more, and its E. M. F. would not change appreciably for a long time. He had found Dr. Gassner's very constant for this purpose, although others might be equally good. A small dry cell kept in a warm closet and used occasionally, had only lost .01 volt, since June 6th last.

An illustration of this method was then given. Fig. 3 shows an ordinary Wheatstone bridge with infinity plug removed and a

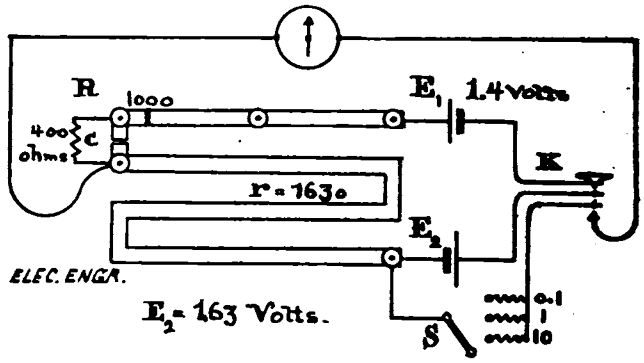


FIG. 3.—LYON METHOD.

compensating resistance coil inserted to insure direct readings. This coil may be adjusted to any change that occurs in the E. M. F. of the standard cell—1,000 ohms is unplugged in one of the arms of the bridge. This with the compensating coil, brought the fixed resistance R up to 1,400 ohms, as the standard cell was known to have an E. M. F. of 1.4 volt. It was found necessary to unplug 1,630 ohms to obtain a balance when the successive contact key K was closed; therefore $E_2 = 1.63$ volt.

For the measurement of current the shunt S is arranged so that the difference of potential may be measured on either side of a known resistance placed around the battery or inserted in the circuit whose current is to be measured. For instance, if one ohm is inserted in any circuit the difference of potential at its terminals has the same value as the current flowing. Therefore a direct-reading voltmeter or ammeter is obtained which still leaves the bridge serviceable for the ordinary measurements of resistance and insulation.

The internal resistance of a battery may be obtained by first measuring its E. M. F. with the shunt S open, which is E; then with, say, the 10-ohm coil thrown around the battery, which may be E'. Then the resistance of the battery $= \frac{E - E'}{E'} \times 10$. It is convenient to have shunt coils of 0.1, 1. and 10 ohms, respectively. To calibrate the dry battery insert a Latimer-Clark or Daniell cell with r, which, with the Daniell, might be 1.079 ohms; then adjust the compensating coil C until a balance is obtained.

After Mr. Lyon had concluded his remarks, Mr. J. Stanford Brown took exception to the statement with regard to commercial ammeters for measuring powerful currents, saying that there were no accurate ones, *i. e.*, accurate within even 5 per cent., on the market. He then described in outline the method of measuring potentials of alternating-current circuits through converters with known reduction factors, etc.,

Mr. Charles E. Emery made some remarks on a bridge method of measuring low resistances, by which, with a little care, the same instruments could be used within considerable limits.

In reply to an inquiry, Mr. Lyon stated that the temperature of the rheostat coils was never affected in ordinary battery measurements. In the case of large currents, as high as 1,000 amperes could be determined by getting the drop in potential through a known resistance, as he had shown.

Mr. Lyon was given a vote of thanks and the president then announced the following committee as appointed to represent the Electrical Department of the Institute at the World's Fair in 1893: J. Stanford Brown, W. D. Sargent, W. S. Barstow, E. F. Peck and F. V. Henshaw.

IMPROVEMENTS IN ANNUNCIATOR AND BELL WORK.[1]

BY CHARLES G. ARMSTRONG.

THE subject of which I will speak will be that of electric bell and annunciator service, especially in large and complicated installations. It is indeed strange, that while all other branches of electrical work have been pushed forward, this one important branch has been seriously neglected. It is almost considered a disgrace for an electrician to be a bell man, in fact it requires some considerable degree of courage for one to announce publicly that he professes to engage in that particular line of business; but I wish to assure you that there is no business where a good class of men are more needed than in bell, annunciator, burglar alarm and district telegraph work, as it requires a better knowledge of electricity and a clearer head than to know how to run the simple parallel lines for electric lighting purposes.

History tells us that James Marsh, an Englishman, in 1824 invented an electric bell which consisted of a pendulum, vibrating automatically between the poles of a permanent magnet. John Mirand, in 1850, invented the electric bell practically as it is to-day, using the vibrating hammer, a push-button, an annunciator, and all of the kindred appliances, for which he obtained a British patent in the year mentioned. Now, strange as it may seem, all inventors turned their attention to a better method of producing electricity before they thought of bettering the supply of current for the electric bell.

In the rush to perfect the electric light, the electric bell and the annunciator, with its modifications, the burgular alarm, were left almost as they were invented, with very few improvements. But of all the neglect of improvement in this particular line, that which received the least attention was the generator of current for bell or annunciator work. It is true that good batteries can be obtained, but it is also true that good batteries are very poor at best.

Let us take, for instance, the large modern hotel with, say, 500 rooms. That means 500 bells, 500 annunciator drops, one or two dozen extra bells, chamber maids' calls, fire-alarm gongs and porter bells. It means an extensive system of speaking tubes which are within themselves almost useless without the ever ready electric bell, and perhaps, on the whole, it will mean 1,200 electrical appliances, scattered over a building which may cover an acre of ground, or more, and distributed over from 6 to 10 stories or more in height.

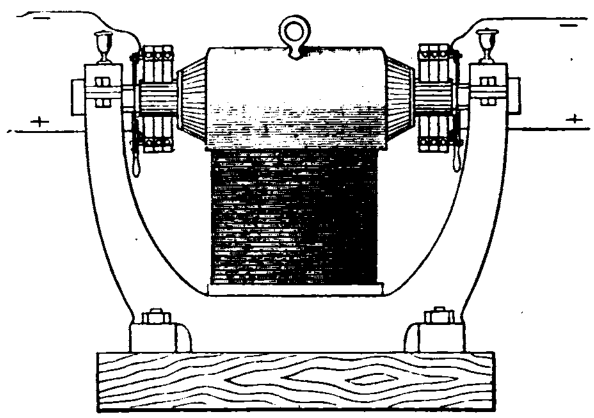
How are you going to handle all these bells? By batteries, of course; there is nothing else. But let us see if there may not be a better way. I present to you a drawing of a machine which was designed by me some years ago and which we will call the battery dynamo. I do not claim to be the inventor of this dynamo but do claim to be the first to use this peculiar form of generator for electric bell service. Since I have had this machine in operation, Professor Thomson and others have used what they call a constant-current transformer, which is very similar in form but entirely different in winding. The drawing which I exhibit is of this little machine which was built for me by Mr. Elmer Sperry and which consists of a bifurcated field having two windings, one end of which is a motor and the other end a dynamo or generator. The armature is double, the two windings being entirely insulated from each other. The motor end is a small shunt-wound motor, wound for 110 volts or any other voltage that one may wish to use and is connected to some convenient supply of electricity, such as may be had in any large city. In many cases you will have that supply within your own buildings, as modern hotels generally have an independent plant that runs night and day; or current can be obtained from some public vender of electricity. The winding of the generating armature is so proportioned that it will give from 1 to 2 amperes at 25 volts pressure, according to the requirements of the plant. I find, however, that this is about the proper current to use.

Now the windings and conditions under which the armature works are such that on a short circuit, the greatest current developed would not be dangerous in any degree to the machine; in other words while having a generator at once desirable and unvarying, you will also have a machine that will run 24 hours a day year in and year out, with scarcely any attention and will give current at all times as desired.

From this dynamo we will carry leads or battery wires with fair cross-section and good insulation. These leads will be run in a looped circuit for equal potential. The loops will have sufficient resistance, when taken together with the resistance of each bell, such that no bell will be overloaded and all will get just enough current to give the best results.

With this arrangement there is no corrosion, no liquid to evaporate, no zincs to waste, no dirty, expensive and unreliable chemical batteries to work with.

Let us now take the case of the batteries. We have the annunciator system, most likely divided into three or four stations, each station being run with from 10 to 20 cells of battery, until, when completed, we will have from 50 to 150 cells of battery scattered throughout the house at such points as we can find space for them, for nobody ever heard of an architect providing space for batteries. In addition to this unwieldy source of supply we must



A MOTOR GENERATOR FOR HOTEL BELL CIRCUITS.

keep sal ammoniac, zincs, etc., handy, and we must constantly visit the different batteries to see that they do not freeze or that the zinc is not corroded or some trivial thing out of order by which certain bells are silenced, thus condemning our whole system, which lacks nothing but a reliable source of constant supply.

In considering the disadvantages of batteries, not the least point is that you are compelled to deal with currents of low voltage or else have too many batteries in service. For instance, 1,000 feet of No. 18 wire offers a resistance of $6\frac{4}{10}$ ohms. It is no exaggeration to state that many circuits in our large buildings are 500 feet long, which would offer a resistance of over three (3) ohms, if it were one continuous wire. A loose binding-post or bad connection would easily raise this circuit to 8 or 10 ohms, which, in connection with a bell of from 4 to 6 ohms and an annunciator magnet of perhaps $1\frac{1}{2}$ to 2 ohms more, would give from 16 to 20 ohms resistance in the entire line. It would follow that with, say, a battery of 10 cells in average condition, giving about 10 volts with large internal resistance, the current would be so feeble as not to operate a sensitive bell, making it possible to have trouble with all apparatus apparently in good condition, while with the battery-dynamo system, with 20 or 30 volts pressure and practically no internal resistance and with the difference of 10 or 15 ohms in the resistance of the line, it would still give sufficient current to ring the bells, and nothing but an absolute break in the line would render the service inoperative.

In regard to call bells, my plan is to place in every room a bell connected with a push-button at the hall door with no connections whatever to the office, treating each room as if it were a private residence. I connect this circuit to the ever ready looped mains leading from the battery dynamo. This method has many points to commend it, not the least of which is the fact that it is of great importance, often, for the patrons of the hotel to depend on certain trains. Many cases of lawsuits for damages have been brought and won against hotels for not having called guests at the appointed hour. The fact that the clerk pushed the button in the lower office would not be evidence in law that he had rung the bell in that particular guest's room, but if the call boy goes to the room mentioned and pushes the button on the outside of the door, he can hear the bell ring and can also receive an answer from the guest that he has been awakened, which would be good

1. Abstract of a paper read before the Brotherhood of Electrical Mechanics, Chicago.

evidence in law and would protect the hotel against any claims for damages.

Further, I do not approve of placing annunciators on different floors of hotels or placing annunciators in the office of hotels, except they be very small ones. A room should be provided near the main office for electrical apparatus, in which the telephone, annunciator or annunciators, speaking tubes and all such apparatus should terminate. This room should be placed in charge of a competent, intelligent young man who has some knowledge of electricity. Sub-offices can then be placed on the various floors which will connect with this main office by speaking tubes, or better yet by pneumatic tubes. All calls will then be placed on record and transmitted to the nearest call boy station and executed with the least amount of delay.

In regard to wire, except your building be entirely of wood, do not use annunciator wire and do not use bare rubber-covered wire, for neither is as good as plain weather-proof. The cost of braided rubber-covered wire is so high as to be practically prohibitory. But weather-proof wire, where saturated with some petroleum compound, I find to be a splendid wire for such purpose, from the fact that it is moisture proof and that it is practically free from damage by mice or rats which are the worst enemies of wire that I know of. Mice dearly love rubber and a very small quantity of moisture will ground an annunciator wire, while weather-proof wire is offensive to mice and rats on account of its waxy covering, and is sufficiently impervious to moisture to make it very efficient for this class of work. It is true that it costs more than annunciator wire, but the first cost only is to be considered, and in no first-class installation, such as I am describing, will the architects or owners object to paying the small additional cost in order to have the better satisfaction, which invariably follows the use of good material. In selecting wire be sure to get one very heavily saturated with compound, the more, the better, as it not only protects from rats and mice but from moisture and abrasion. I admit that in wooden buildings where lath and pine studding is used, annunciator wire will do very well for use, but when you consider that bare wire, properly placed under the same conditions, would answer nearly as well, you will see that it is no recommendation for the annunciator wire.

As to the manner of laying wires in the modern fireproof structures with tile partitions, I prefer to use the paper tubing which is now manufactured under the name of interior conduits. One sample is covered with brass. This is designed to use where it is necessary to have the wires exposed. There are a few cases perhaps where it may be necessary, but it can be polished and made very ornamental if desired. The other tube is to be covered entirely by the plastering and offers a channel into which the wires can be drawn at any time. In the halls at suitable points I place wooden troughs, concealed by the decorations, so that every wire in the building can be inspected from end to end without taking up a carpet, removing any plastering or in any way disturbing the occupants of the building.

It has been my object for many months to improve in every way possible the present method of laying wires within large buildings, and I always keep in view the fact that accessibility to the wires is the greatest object to be attained in work of this kind. The architect who spends months designing the beautiful decorations for our modern buildings is certainly not to be blamed for losing his patience when, on account of faulty insulation, the wires have to be torn out and his decorations totally destroyed or marked by patching which is never satisfactory. By the proper design and arrangement in conduits, every inch of the wires, from the annunciator to the push-button, can be drawn out in a few moments and repaired in case of accident from any cause whatever.

In regard to district telegraph or fire-alarm work, this battery dynamo is equally as efficient as it is for bell work, as it at once does away with the uncertainty of batteries, concentrates your apparatus and greatly reduces the cost of maintenance. In the city of Chicago, which undoubtedly has the best fire-alarm system of any city in the world to-day, there are in service nearly 3,500 cells of battery. This does not include the batteries used in Hyde Park and Englewood. It would be perfectly feasible to replace every cell with from six to 10 of these little machines.

In closing my remarks I would like to say to each and every one of you, Make it your object to discourage and discountenance everything in electricity that is bad, and encourage that which is good.

In this connection I will call your attention to two things which I wish to emphasize in particular. First, the placing of electric gas lights on fixtures which carry electric lights. It is the practice in work of this kind to ground one side of the battery. Now as you are all well aware, the fixture man has gone to considerable expense and taken valuable time to place on every fixture an insulating joint, the object of which is to entirely separate that portion of the electric light which is most apt to ground, from the sockets and pipes, which of course afford excellent ground. You proceed to undo all this work by bridging over his insulating joint with the gas lighting wires which are little better than bare wire, so far as insulation goes, and practically annulling the effect of the insulating joint.

Another dangerous thing is the electric trap-door, and there is a building in this city where a sort of "dead fall" controlled by an electric trigger is placed at every point of exit. Hundreds of people, men, women and children are employed in that building every day. In case of fire, every stairway, the elevator shafts, and almost every means of exit will be automatically closed. Against such devices as this I should expect to find you all arrayed.

ON POLYPHASAL GENERATORS.[1]

BY M. I. PUPIN, PH. D., COLUMBIA COLLEGE.

FEW will deny the importance of the polyphasal current systems; none the fascination of their study. This belief induced me to present the following brief essay before the Institute.

The experimental researches in this new and promising field of electrotechnics are not yet numerous, but still the results already obtained are of so decisive a character as to leave no doubt whatever as to the extremely high practical importance which is attached to electrical generators, motors and transformers constructed according to requirement imposeds upon us by this new

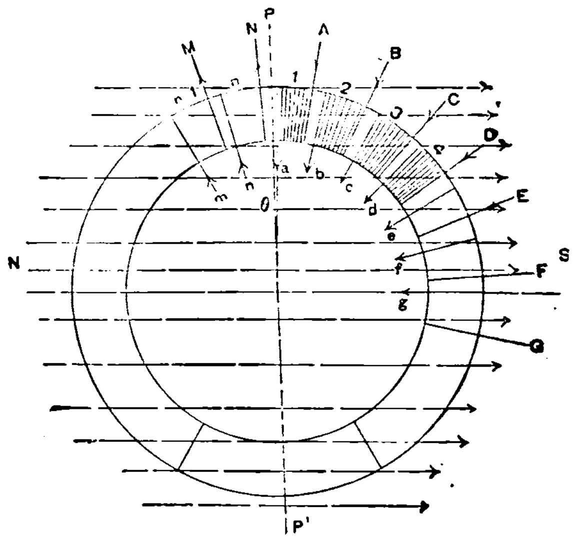


Fig. 1.

method of combining a set of variable electromotive forces. For who among us does not thoroughly appreciate the beautiful inventions of Nikola Tesla and the completeness of the success which Dobrowolsky and Brown obtained by the practical applications of these inventions?

The exact quantitative relations involved in the polyphasal system of currents are not, I venture to say, quite as well known as its practical results. To give an impulse to further inquiry in that direction is one of the principal aims of this modest investigation. For the present I propose to confine myself to the polyphasal generators in general, and particularly to polyphasal generators whose system of electromotive forces is capable of producing a rotary magnetic field of constant strength. The last point seems to me to be one of the vital points in this new method of electrical distribution. It is in this particular point that Mr. Dobrowolsky claims his system to be superior to that of Nikola Tesla.

Let us consider the theoretically simplest form of a polyphasal generator, as shown in Fig. 1. A non-magnetizable ring with n open equal coils at equal distances from each other rotates uniformly through a perfectly homogeneous magnetic field. Let PP' be the neutral plane of the field. At the instant when coil 1 is at the angular distance θ from the neutral plane PP' the E. M. F. generated in the various coils will be

$$e_1 = K \sin(\theta + \alpha)$$

$$e_2 = K \sin\left(\theta + \alpha + \frac{2\,\pi}{n}\right)$$

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1. Read at the sixty-second meeting of the American Institute of Electrical Engineers, New York, December 16th, 1891.

$$e_n = K \sin \left\{ \theta + \alpha + (n-1)\frac{2\pi}{n} \right\}$$

Where K is a constant depending, as is well known, on the field intensity, the speed of rotation, the number of turns in the coil and the area of the plane of a turn; α is the angular width of one-half of the coil.

Since

$$\sin(\theta+\alpha)+\sin(\theta+\alpha+\frac{2\pi}{n}+\ldots\ldots+\sin\left\{\theta+\alpha+(n-1)\frac{2\pi}{n}\right\} = 0$$

it follows that

$$e_1 + e_2 + e_3 + \ldots\ldots + e_n = 0 \ldots\ldots (1).$$

That is to say, the sum of electromotive forces generated in the various coils which are on one side of the neutral plane is numerically equal and of opposite sign to that of the coils on the other side of this plane. This result is well known and self-evident. It is, however, far from self-evident that relation (1), which I shall call the *relation of continuity* for the electromotive forces, will be satisfied by every magnetic field.

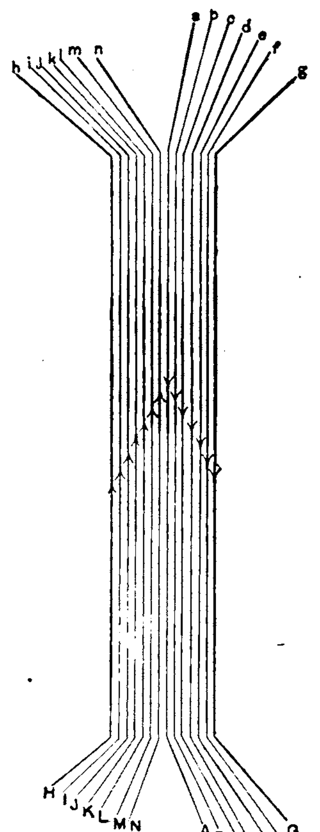

Fig. 2.

Close each coil separately by conductors of equal resistance and self-induction. Let $c_1, c_2 \ldots\ldots c_n$ denote the currents in the n separate circuits. It is evident that

$$c_1 = \frac{K}{I}\sin(\theta + \alpha - \varphi)$$

$$c_2 = \frac{K}{I}\sin(\theta + \alpha + \frac{2\pi}{n} - \varphi)$$

$$c_3 = \frac{K}{I}\sin(\theta + \alpha + 2\frac{2\pi}{n} - \varphi)$$

$$c_n = \frac{K}{I}\sin\left\{\theta + \alpha + (n-1)\frac{2\pi}{n} - \varphi\right\}$$

Where I is the impedance in each circuit and φ the angle of retardation. Hence, we have

$$c_1 + c_2 + c_3 + \ldots\ldots + c_n = 0 \ldots\ldots (2).$$

That is to say, the relation of continuity is satisfied for the currents also.

Let the wires $a\,A$, $b\,B, \ldots\ldots n\,N$ (Fig. 2) represent a part of each of the n conductors of this system. Then, according to relation (2), the sum of the currents in these n linear conductors being always zero, if we join them all into one conductor there would be no current in this wire, but the currents in the n circuits would circulate exactly the same as before. In fact, the common juncture is useless and can and should be cut out.

The diagram, Fig. 3, represents this method of connecting for a three-phase system. Consider, now, n equal coils distributed at angular distances of $\frac{2\pi}{n}$ over a laminated iron ring B, each coil being a part of the n conductors coming from the generator Diagram Fig. 4 illustrates this for a three-phase system. Let the n currents be denoted now by $c_1', c_2', \ldots\ldots c_n'$. We shall have now,

$$c_1' = \frac{K}{I'}\sin(\theta + \alpha - \varphi')$$

$$c_2' = \frac{K}{I'}\sin(\theta + \alpha + \frac{2\pi}{n} - \varphi')$$

$$c_n' = \frac{K}{I'}\sin\left\{\Theta + \alpha + (n-1)\frac{2\pi}{n}\varphi'\right\}$$

and therefore

$$c_1' + c_2' + \ldots\ldots + c_n' = 0 \qquad (3)$$

The introduction of the iron ring with the n coils into the n phasal system has changed the impedance I, and the angle of retardation φ; but this change is evidently the same for all coils. The correctness of this statement might, perhaps, be questioned, if we suppose that the system of the n variable currents was at any moment strong enough to saturate the iron ring; I therefore suppose that the intensity of magnetization in the ring is never over 10,000 C. G. S. lines of force. We shall presently see that in the case of a properly built generator the saturation of the iron ring will not vitiate the correctness of the above statement in the slightest.

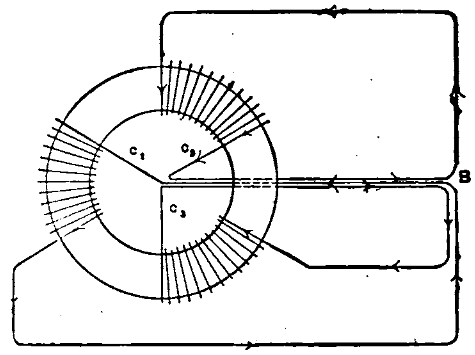

Fig. 3.

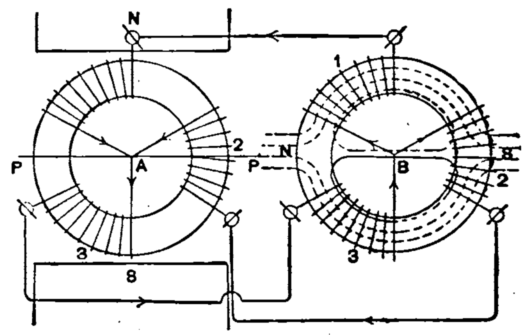

Fig. 4.

Let s be the number of turns in each of the n coils. Relation (3) gives

$$4\pi s c_1' + 4\pi s c_2' + \ldots\ldots + 4\pi s c_n' = 0 \qquad (4)$$

That is to say, the relation of continuity is satisfied by the magneto-motive forces.

Relation (4) translated into physical language means that the magnetization in the iron ring is due to two equal magneto-motive forces working in multiple arc. The magnetic field produced is perfectly symmetrical with respect to the ring as indicated by the dotted lines in Fig. 4.[1]

MR. C. O. HARRIS, formerly of Clower, Harris & Co., Dallas Tex., was in the city last week. Mr. Harris has secured some excellent agencies, and will open an office in Dallas.

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1. This will be always strictly true if we employ an even number of coils, even if the number of phases is odd, because then the distribution of the ampère turns is perfectly symmetrical.

SOME PRACTICAL FORMULÆ FOR STREET CAR MOTORS.

BY

Thorburn Reid.

The following analysis was undertaken with the object of obtaining some simple, practical formulæ, which could be used by a practical man in his everyday work. Accuracy has been sacrificed to simplicity, since accuracy in this case would hardly be required by the engineer, and, if it were, it could seldom, if ever, be attained on account of the wide variations in the conditions affecting the problem.

First take the case of a gramme ring armature in a two-pole field, the field coils being in series with the armature coils. If e is the counter E. M. F, S_2 the number of turns on the armature, n the revolutions per minute, and N the number of volt lines (10^8 c. g. s. lines = one volt line),

$$e = S_2 N n. \tag{1}$$

But $N = \dfrac{S_1 C}{\rho}$ where $S_1 C$ is the number of ampere turns in field and ρ is the magnetic resistance of the magnetic circuit. Therefore, $e = \dfrac{S_1 S_2}{\rho} C n$ (2)

If R be the resistance of the field plus the armature, and E the line E. M. F., then

$$C = \frac{E - e}{R} = \frac{E - \dfrac{S_1 S_2}{\rho} C n}{R}$$

solving for C, we have

$$C = \frac{E}{R + \dfrac{S_1 S_2}{\rho} n} \tag{3}$$

If w be the work done by the motor,

$$w = C e = \frac{S_1 S_2}{\rho} C^2 n \tag{4}$$

S_1 and S_2 and ρ are constants of the motor. ρ, however, varies somewhat with the saturation of the field. We will not, however, introduce too large an error by considering it constant throughout the range. If, therefore, we substitute for $\dfrac{S_1 S_2}{\rho}$ the letter a, a constant, (3) and (4) become

$$C = \frac{E}{R + a n} \ (3) \qquad w = a C^2 n \ (4).$$

The value of this constant may be obtained easily if we have the dimensions of the magnetic circuit and a saturation curve of the iron in field and armature, but this, in the present stage of electrical manufacture, is not generally to be had. The following method is far simpler, and no doubt more accurate:

Let the motor whose constant is required be run under load and a reading be taken of E, C and n. Substituting these values in equation (3) we may obtain the value of a thus: $a = \dfrac{E - C R}{C n}$ (5)

This may be made more accurate and the variation in ρ taken into account by taking readings at varying loads and currents and obtaining the value of a for each case.

The value of a thus obtained will then be good for all motors of that type and size for all practical purposes. Of course, if the number of turns on field or armature be varied, the value of a will be changed.

If the motor be of the four-pole type, or if its armature be a Siemens instead of a Gramme ring, the same equations may be used, provided a is obtained by experiment, as above; for in the former case the only change to be made is to multiply n by 2, which, being a constant, would be included in a, and in the latter case the right-hand member of equations (1) and (2) would be multiplied by 2, which would again be included in a, since (2) could be written, $e = a C n$. Another convenient formula is the following:

If m be the speed of the car in miles per hour, d the diameter of the car wheel in inches, and r the ratio of reduction, or the ratio of the revolutions of the armature to those of the car wheel, we will have

$$n = \frac{5280 \times 12 \times m \times r}{60 \times \pi \times d} = \frac{304 \ m \ r}{d} \tag{6}$$

Having obtained the value of a, then the next step is to apply these equations to problems occurring in practice. A problem, which often occurs, is, what E. M. F. is required on the overhead line to drive a car up a particular grade at a certain rate of speed.

From (3) we have $E = C(R + a n)$ in which everything is known except C. But C can be obtained from equation (4), provided we know the value of w. w depends on five things—friction, grade, condition of track, curvature of track and speed. No general formula can be given for the resistance due to friction, condition of track or curvature. These can only be determined by experience and must be largely a matter of guess-work. The friction will vary largely at different times in the same car, depending on the care with which the gears and bearings are oiled and on whether the track is wet or dry, clean or dusty or muddy. A rough value may be arrived at by taking readings of the current and line E. M. F. at varying speeds with the car running on a level, straight track. This resistance may be taken to vary directly with the weight of the car plus its passengers. We obtain w by substituting these readings in equation (4). We find the work required to overcome the grade as follows:

$$w_g = \frac{P \times ft.\ per\ min. \times 746 \times g}{100 \times 33{,}000}$$

where P is the weight of car plus passengers and g is the grade in per cent. That is, the rise in feet per hundred feet. Or $w_g = .02 \ m \ g \ P$

where m is as before the miles per hour.

The work which would be done by the motors then in climbing the grade will be that obtained by equation (7) plus the work required on a straight, level track, since this latter factor is assumed to be constant whether the car is going up or down grade or on a level.

In making the experiments to obtain w on a level we must be careful to notice the load that the car carries, since this work at any speed varies directly as the weight of car plus its passengers. Probably the simplest procedure would be to divide the work thus obtained by the weight of cars plus passengers, thus obtaining the work for one pound, which can then be multiplied by the total weight (average weight of a full-grown passenger may be taken to be 125 pounds), calling this value w_1, the complete formula will be

$$w = P(w_1 + .02 \, m \, g). \tag{8}$$

Of course, w_1 must be determined for the same speed as that required at the point in question or else it must be estimated from the data at hand. Probably the best assumption we may make is that the work on a level varies as the speed, or

$$w_1 = b \, n \tag{9}$$

b being a constant depending on the condition of the road-bed, etc., and is most easily determined by running the car and taking readings of C, E, and n, substituting for w_1 and n in equation (9) and solving for b.

Having thus obtained the value of w, we may substitute it in (4) and obtain C and then substitue C in (3) and obtain (E). We are thus enabled to determine the size of wire required in the feeders to maintain a certain speed at any point on the line.

Society and Club Notes.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

The fifteenth convention of the Association will be held at the Iroquois Hotel, Buffalo, N. Y., on February 23, 24, and 25. Secretary Porter announces that Mr. C. O. Baker, Jr., has been appointed general master of transportation with headquarters at the office of the Association, 136 Liberty street, where all communications relating to transportation should be addressed. Steps are already being taken to make the meeting a great success.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the meeting of the council on December 16, the following gentlemen were admitted to associate membership:

Ayres, Brown, professor of physics and electrical engineering, Tulane University, New Orleans, La.

Benjamin, Park, electrical expert and engineer, 32 Park Place, New York City.

Bishop, James Draper, electrical expert, John A. Roeblings' Sons Co., 345 West Thirty-fourth street, New York City.

Parcelle, Albert L., electrician and inventor, 157 Washington street, Boston, Mass.

Pike, Clayton W., instructor in electrical engineering, University of Pennsylvania, Philadelphia, Pa.

Robb, Wm. Lispenard, professor of physics, Trinity College, Hartford, Conn.

Applications for transfer from associate to full membership, as follows, were approved:

Smith, T. Carpenter, firm of M. R. Muckle, Jr., & Co., Philadelphia, Pa.

Taintor, Giles, assistant electrician, N. E. Tel. & Tel. Co., Boston, Mass.

Pattison, F. A., firm of Pattison Bros., consulting and constructing electrical engineers, 135 Broadway, New York.

THE FRANKLIN EXPERIMENTAL CLUB.

The Franklin Experimental Club, of Newark, N. J., has changed its regular meeting night from the second and fourth Tuesdays of the month, to the second and fourth Saturdays in the month. There has been a considerable increase in the membership of late and a committee has been appointed to look for larger and more suitable quarters, the club having outgrown its present facilities. Among the subjects that have been taken up at the recent meetings, are "Induction," "Construction of Transformers and Applications of Alternate Currents," "Vibratory Phenomena." A series of talks illustrated by experiments are now being given upon the latter subjects by the various members, illustrating in a most interesting way the phenomena of sound, light, heat, and electricity, and their correlation.

THE BOSTON ELECTRIC CLUB.

Mr. R. F. Ross, secretary of the Boston Electric Club, writes us:

It having been announced in some of the electrical journals that "the New England Electric Club is to be formed to take the place of the Boston Electric Club," will you kindly, in justice to the Boston Electric Club, state in your next issue that such is not a fact. The Boston Electric Club is not dead, nor have we surrendered our charter. We have simply given up our permanent headquarters and disposed of our furniture and effects. Henceforth the club will be perpetuated in the form of monthly dinners, lectures, etc. Our constitution and by-laws have been revised, annual dues reduced to an almost nominal figure, and such other changes made that we think will tell beneficially, and on the first Monday evening in January (the 4th), we propose having our Inaugural Dinner. I know nothing of the New England Electric Club except what has been published nor, have I seen any one who can tell me anything about it.

College Notes.

ELECTRICAL ENGINEERING AT THE A. & M. COLLEGE.

The trustees of this college (Birmingham, Ala.) are keeping in progress with the age, and have established a Special School of Electrical Engineering and equipped a laboratory with different styles of dynamos and electrical appliances for instruction in the applications of electricity. We are indebted to Prof. A. F. McKissick for an interesting little pamphlet on the subject. The equipment is still small, but it is the intention of the Alabama Polytechnic Institute to build it up year by year.

Reports of Companies.

THE CARD ELECTRIC MOTOR CO.

Changes in the management of the Card Electric Motor Co. during the last few days started the rumor that this company had failed; in fact such information was telegraphed to a number of cities. However, The Electrical Engineer, having a representative in the vicinity, immediately took steps to ascertain the true state of affairs. It seems that the entire concern has been purchased outright by Mr. J. W. Wilshire, with a view to its immediate re-incorporation under the laws of Ohio, it having been heretofore under the laws of Kentucky. Mr. Dixon, the efficient general manager of the old Card Company, will remain in that capacity with the new organization. The wealth of the individual stockholders of the Card Electric Motor Co. made it seem incredible that the house was going into the hands of a receiver. In the meantime we are informed that most of the creditors have only recently received checks in full settlement of their accounts —another very good indication of the condition of the company's finances. Mr. Wilshire expects to have things running along smoothly under the new regime in the course of a few weeks, and in the meantime the factory is working "full blast" as usual.

Appointments, Etc.

Mr. W. H. Girvan, general superintendent of the Central New York Telephone Co., with headquarters at Syracuse, has handed in his resignation, to take effect Dec. 31. The resignation has been accepted, and Walter W. Nicholson, of Utica, has been appointed to fill the position. Geo. W. Wood, who has been division superintendent in Herkimer county, with an office in Little Falls, will succeed Mr. Nicholson as division superintendent for Oneida, Madison and Lewis counties. Mr. Nicholson, the new general superintendent, is a son of General Manager Charles A. Nicholson, of Utica, formerly of Rome. He will have his office in room 46, Mann Building, Utica, on the same floor with the executive offices of the company.

Mr. George Albree has assumed the duties of superintendent of the Boston division of the New England Telephone Co., relieving Mr. Denver, who will continue to serve as assistant to Mr. Keller.

Mr. Homer E. Mason has succeeded Mr. H. A. Wyckoff as superintendent of the Delhi Electric Light Co., of Delhi, N. Y.

Personal.

Mr. George North, M. I. M. E. and A. I. E. E., who has been for some years general manager of Woodhouse & Rawson United, Limited, the well-known electrical and mechanical engineers of London, England, has resigned his appointment in order to commence business as a consulting engineer, valuer and arbitrator, at 90 Queen street, London, E. C. A special feature of Mr. North's business will be the purchase, sale and development of new patents and inventions; and he will also act as London agent for mechanical and electrical specialties.

Obituary.

W. H. BAUER.

Mr. W. H. Bauer, one of the oldest telegraph operators in the country, died on December 14, at his residence, Baltimore, Md., of pneumonia. Mr. Bauer was 73 years of age and had been an operator since 1846. He worked for the Southern Telegraph Company until its amalgamation with the Western Union, when he went into the employ of the Baltimore and Ohio, where he remained up to twelve years ago, when he returned to private life. Mr. Bauer took an active interest in Masonry. The son of the deceased, Mr. Alexander H. Bauer, the electrical engineer of the Pullman Car Company, came on from Chicago to attend the funeral. Mr. Bauer was buried with Masonic honors.

Letters to the Editor.

REACTIVE COILS AND THE RIES REGULATING SOCKET.

In your issue of Dec. 16th, Prof. Elihu Thomson, in commenting upon Mr. Otis K. Stuart's article on "Reactive Coils," published in your issue of the previous week, takes occasion to criticise the results obtained by the Ries Regulating Socket, kindly referred to by Mr. Stuart as being probably the most interesting application of the reactive coil principle, and at the same time endeavors to show that he anticipated the invention in his patent No. 428,647, and states that he had in operation some years ago several such "regulating arrangements" in his house in Lynn.

In view of Prof. Thomson's own admission that the principle involved in the construction of reactive coils was known many years before he was born, and in view of the fact that not only reactive coils, but reactive coil regulators were well known in the art and had long since been used by myself and others for regulating the flow of alternating current to incandescent lamps and other translating devices, it is scarcely necessary for me to say that a patent describing a specific improvement in reactive coils, as does the one referred to by Prof. Thomson, is not only something entirely different from a regulating socket, but scarcely amounts to an invention over the prior art in view of the earlier patents to Hopkinson (Eng. 3,362 of 1881) and others, showing substantially the same arrangement.

The use of reactive coils for regulating groups of lamps, of which Thomson's patent referred to is an example, has been customary in isolated cases almost since the introduction of the alternating-current system of lighting in this country, as exemplified by the well-known but somewhat bulky "stage regulator" in common use; and it is quite probable that the "regulating arrangements" used in Prof. Thomson's house were of this character. I venture to say (and I am supported in this assertion by Prof. Thomson's closing sentence) that, despite the professor's ingenuity and varied experience with alternating-current apparatus, he had not only never made, but had never even *thought it possible to construct*, prior to the time he experimented with the Ries regulating socket, a reactive coil small enough to go into a lamp socket and yet perform the work required of it as thoroughly and efficiently as this socket does it.

In regard to Prof. Thomson's statement that the economy effected by the Ries regulating socket is "problematical," all that need be said is that if the professor had taken the time to measure the amount of energy consumed by the lamp and socket at the lower stages of light, upon one of his own wattmeters (provided he had one sensitive enough to measure it), and compared the result with the number of watts consumed by the same lamp at full candle power, he would have found this method of regulation to effect a very considerable and most surprising economy that would at once have settled any lingering doubts he may have had on this question. Of course, it is well known that, as stated by him, a certain amount of energy is absorbed in heating the filament before it reaches the incandescent stage, but it is a fact not so generally known that the energy thus absorbed forms an exceedingly small fraction of the total number of watts required to raise the lamp to full candle power.

While the writer is not as yet at liberty to go into a detailed description of the socket, he may say that by its use he has been enabled to burn from eight to ten 25 c. p. incandescent lamps at a dull red glow, sufficient to enable one to locate the position of each lamp in the dark, at a consumption of less energy than was required to burn one of these lamps at full candle power. As the light is turned down, not only the current, but the electromotive force at the lamp terminals necessary to pass this current through the filament, is reduced. And since the efficiency of the socket itself, owing in part to its peculiar construction, is almost perfect under the conditions noted, the amount of energy consumed in producing this light is exceedingly small.

It is true that lamps are much more efficient when burning at high than at low candle powers, but this fact, if it has any bearing at all upon the socket, only makes it the more valuable, for the reason that the socket is not merely capable of burning the lamp at its normal brilliancy or candle power the same as any ordinary socket, and is ordinarily intended to be so used when the usual amount of light is desired, but because by its use the consumer is enabled to burn his lamps, if the latter are of the proper voltage, *above* as well as *below* their normal candle power. It will therefore be seen that by means of this socket the consumer is not only entirely independent of the variations of potential that are constantly occurring on the line from occasional overload and other causes, and which frequently prevent him from obtaining sufficient light, but he is enabled at all times to obtain a maximum amount of light, when much light is wanted, at a higher lamp efficiency and therefore at a proportionally less cost per candle power for current, as well as to turn down the light and thus save both current and lamps when less light is desired, or to keep ome of his lamps burning at a still lower degree of brilliancy during the entire night where, under the present conditions, they would be turned out altogether. In short, this socket gives the consumer complete control of his own lamps, and for the first time places the incandescent electric light upon an equal footing with gas, in that it permits him to burn much or little light, as he may desire, during the time his lamps are in service, and at a cost for current directly proportional to the energy consumed.

The history of invention shows that it is an exceedingly simple matter after a thing has been successfully done, to see how something else *might* have been made to do the same thing. But the fact remains that, despite the great demand that exists and has always existed since the invention of the incandescent electric lamp itself, for a simple and efficient holding device that would permit of turning the lamp up and down without waste of current, and despite the further fact that reactive coils of the ordinary type have been for several years in almost daily use by many of the most prominent electricians and experimenters of the world, and have occupied a foremost place in nearly every electrical laboratory and workshop, it has nevertheless remained for the writer to produce the desired article to successfully supply this demand by the invention of the Ries "Regulating Socket." It is perhaps needless to add that alternating current incandescent lighting is already beginning to feel the impetus that this socket has given to it, and that not only the public generally, but central stations supplying current on the meter system, are reaping a decided benefit therefrom.

ELIAS E. RIES.

BALTIMORE, MD., December 17th, 1891.

THE HUM OF MOTORS.

I was much interested in the article by Mr. Charles J. Hayes entitled "The Hum of Motors," which appeared in your issue of December 16, 1891. I have been much puzzled to find a satisfactory explanation of the phenomenon which he discusses, but I am forced to confess that I am unable to understand his explanation of the cause.

Sound-waves in the air are necessarily either set up by the movement of some body surrounded by, or in contact with the transmitting gas, or set up by some force or forces other than those derived from motion. If sound-waves are derived from motion, that motion must be one capable of moving the surrounding air.

Mr. Hayes explains at some length a possible raising or distortion of the armature under each pole-face which, he thinks, though ever so slight, would be capable of setting the air in vibration, as the rotation of the armature shifts the points of distortion along the surface of the armature. In his words: "Now, by revolving the armature it will be seen that every part of its circumference will be brought in succession in front of each of the poles, and, consequently, attracted and slightly raised as it passes, producing a progressive undulatory movement of the iron, like waves on a body of water."

Mr. Hayes' waves, like his hypothesis, may be progressive, but they are not *sound*, and, indeed, I may add they are not even progressive, since it is merely the particles of the armature that progress. The undulatory distortion is fixed in space. His simile of waves on water would better be those fixed waves that one sees on some swiftly flowing rapids where no movement exists save that of the moving particles that lie within the fixed contour of the whole body.

As there can be no movement of the air produced by such fixed undulations, I am unable to find in his supposition any cause of the phenomenon of the hum of armatures. It is this point that I would beg him to elucidate, as, till he does, his speculations are hardly entitled to rank with the less plausible but perhaps more admissible theories already somewhat numerous.

HAROLD BINNEY.

NEW YORK.

THE BURNET ROSETTE AND SWITCH.

In the early days of the electric light business we learned that the way to invent a dynamo was to take the other fellow's machine and paint it red. This is good doctrine and has been generally accepted and widely followed. Once in a while, however, it happens that the inventor neglects to apply the saving coat of red paint, and I wish to call attention to a very flagrant case of the kind. In the issue of THE ELECTRICAL ENGINEER for December 9th, appears an article with the above heading written by H. W. Burnet, describing a rosette and switch which has been advertised and sold by the Electrical Supply Co. for about a year. As the article referred to does a slight injustice to my company I wish to state the facts as a matter of justice.

The original of the rosette switch in question was designed by me, and the drawing is now before me, bearing date January 18, 1889. It is designated "Ceiling Cut-Out with Off and On Switch," to be operated by one pendant cord. Nothing was done with this until in the summer of 1890 I ordered from Mr. Burnet, for the Electrical Supply Co., two or three models, and later 500 of the cut-outs, which are identical with the half tone shown on page 622 of THE ELECTRICAL ENGINEER of December 9th, 1891. I learn from the *Patent Office Gazette* that Mr. Burnet has applied for and received a patent on this device. This he is entirely welcome to keep for what it is worth, as the particular mechanical action involved has been superseded by a simpler and more satisfactory one.

The whole thing is of the very slightest importance. Sensible inventors are not in the habit of taking out patents on this class of mechanism at all, very much less going out of their way to patent other people's inventions of such small value. I would not waste space and time in calling attention to the matter at all, but for the particularly brazen nature of Mr. Burnet's assumption. In my small experience as an inventor, it has not fallen to my lot before to meet with any one willing to accept orders for models, to build the same according to instructions, to fill an order for goods in quantity built according to such models, and afterwards claim the whole thing and apply for a patent.

CHARLES WIRT.

CHICAGO, Dec. 12, 1891.

Legal Notes.

INCANDESCENT LAMP LITIGATION—THE UNITED STATES ELECTRIC LIGHTING CO. vs. THE EDISON LAMP CO.

ARGUMENT OF FREDERIC H. BETTS FOR THE EDISON COMPANY.

MR. BETTS in opening the case for the defence, remarked that his brother Kerr in his opening as well as in his concluding remarks had made a statement with which he thought he ought to begin; namely, that the case was one of strong equity on the part of complainant. He could not but disagree entirely with that statement. Let us—said Mr. Betts—carry ourselves back and try to appreciate the true status of the several inventors at the time when this invention was made.

About the year 1877 the whole world of electrical thought had been intensely interested in the problem of the production of electric light by incandescence. Many inventors, both in this country and abroad, had been struggling with this problem for more than 30 years. The whole atmosphere of thought had now been quickened by a sense of some impending discovery, which should render practical the dreams of inventors and scientists. Fontaine had in many respects fairly stated the condition of the affairs existing at the time he wrote. He said :—

Lighting by incandescence has been studied for a long time ; but its application generally presents so great difficulties that at the present day it may be considered as within a purely scientific domain, although a certain number of apparatus exists working moderately well.

That had been the condition of affairs in 1877. The best result which had been attained, according to Fontaine, had been an average duration of the carbon of 21 minutes, but in no case had its length of life been greater than two hours. It would seem, therefore, that had anybody really invented anything tending to materially increase the life of the incandescent lamp he would not have been slow to have communicated that momentous discovery to those who were able to appreciate the importance of such an invention. Weston, the patentee in this case, was a well-known electrician, who is and has been for many years an expert. He had been equipped even at that time, with all the requisite facilities for construction and experimentation. He was an expert in words too, with a remarkable facility of stating in the most favorable way to himself any claims which he might put forward. Upon the face of this case there stood out one most important fact. There was no contemporaneous record of the experiments which Weston is alleged to have made. On the contrary, the evidence of the witnesses who have testified in support of his contention wholly fails to corroborate him in respect to the most vital points. He contended that Weston stood wholly alone in his endeavor to prove that he had perfected a process of treating carbon conductors, or that he had applied that process to the making of conductors of incandescent lamps, at the early date assigned by him, the summer of 1877; or that he had then in fact acquired any knowledge or made any discovery in advance of that which the world previously possessed.

Very different was the way in which other inventors had acted in regard to this same invention. Sawyer and Man had been proved without contradiction to have practised this process of making carbon as early as the 6th of March, 1878. They had filed an application for a patent accompanied by a model which contained a treated carbon. Their patent had been issued June 25, 1878. October 15, 1878, they had filed an application for the process of treating carbons, which had been granted January 7, 1879. Weston's application had not been filed until two years and four months afterwards. Sawyer and Man had exhibited their lamps in the most public manner. Large numbers had been invited to see them. The process of hydrocarbon treatment had been employed in their factory. It had been fully described and illustrated in publications more than two years before Weston had applied for his patent. Another inventor, Maxim, testified that he had also practiced this process, that he had made such a lamp as early as June, 1878, and that he had filed an application for a patent in October, 1878. It was idle for complainant to contend that Maxim had not appreciated what he was doing. Maxim had been the electrician of the United States Electric Lighting Company. They had prosecuted his application. They had asserted him to be the first inventor. An interference had been declared between Maxim and Sawyer and Man, in which Sawyer and Man had been successful and had been declared the prior inventors. Maxim had thereupon dropped the contested claim. In June, 1880, the United States Company commenced making lamps. All through 1880 they had made lamps at Bridgeport and late in that year they started up a plant of lamps, lamps made by Maxim and not by Weston. The United States Company were then exploiting Maxim's invention, as appears by an article in the record from the *Evening Post*. Not until the spring of 1881 was Weston first heard of in this connection. Mr. Curtis in his testimony has said that it was in February or March, 1881, that he first formed the acquaintance of Weston. Mr. Betts then read from the testimony the history of the unsuccessful negotiations with Sawyer and Man in relation to this invention. This was in the spring of 1881. Weston had done nothing to get his invention into public notice, while Sawyer and Man had done everything they could do, by patenting, publishing, and manufacturing lamps as well as they could manufacture them. The United States Company had tried to get a license from them and it was only after it had failed to do so that Weston had first been heard of. In a conference in 1881 between Curtis and Weston, Weston had made the claim that he was the inventor. In 1881, after the public had for two years been in possession of the full knowledge of this invention an application had been filed in behalf of Weston. Subsequently, it did not appear when, the Sawyer and Man patents had also come into the control of the Westinghouse Company, which also now controlled the United States Company. Now it had become very important to belittle everything that Sawyer and Man had done, for by means of a patent granted in 1885, this complainant company would obtain control of the invention for a much longer term. There was nothing to show that the application of Weston had ever been thought of by him or by anybody else, until the exigencies of this complainant had compelled it to have an application for a patent made in the name of Weston.

His brother Kerr has contended that the work of Maxim had eventuated in nothing practical, but he did not think that the facts would sustain him in his contention. The first commercial plant had not been made by Weston, nor did he have anything to do with it. He (Mr. Betts), asserted that the public derived a practical knowledge of this invention, not from Weston, but from somebody else. By way of emphasizing this state of facts he would refer to the stipulation in the record. Depositions taken in a suit on the Sawyer and Man patent had been stipulated into a suit on the Weston patent and the suit had been brought on that patent, because it had the longest time to run. It had been admitted by Mr. Pope, the complainant's own expert, that no less than four prior patents—two English and two United States patents—contained a full disclosure of the invention, or sufficiently full at least, to enable a person skilled in the art to practice the invention.

Such a state of facts—continued Mr. Betts—puts upon the complainant the burden of proving, with the utmost certainty and beyond all reasonable doubt, that Edward Weston had completed the invention before any of these others inventors.

Another feature which he should refer to showed that there was no great equity in this case. The Edison Lamp Company did not use this invention in commercial practice. There was proof of a course of experimentation, of a few weeks, or a few months; the making of a few thousand carbons at the lamp factory in 1884 and 1885. There was not one particle of proof that they had ever put one of these carbons into a lamp. The process had been abandoned; it had never been used in a single commercial lamp from the beginning down to the present time. The Edison lamp was made of bamboo, carbonized in a furnace and then electrically heated in a vacuum to drive out occluded gases. It was sealed up by electrically heating, not in a carbonaceous atmosphere, but in a vacuum. The witnesses had testified as to the number of carbons treated; some 20,000 others 9,000, and so on, figures which might sound large, but which were wholly insignificant in view of the fact that at the present time 25,000 lamps per day were being manufactured with untreated carbons, so that the whole amount testified about actually did not amount to one day's commercial production. The defendant had been prosecuted for a mere experimental use of a process which had never been used in its commercial manufacture.

There were three propositions of law to which he should ask his Honor's assent as applied to the facts of the present case.

First.—He is the first inventor, in the eye of the law, who reduces the invention to a fixed, positive and practical form; for until he has done this he is not in a position to give to the public what it has a right to demand. In a race of diligence between two inventors, he is not the inventor who first conceives the possibility of producing a certain result, but he who so perfects the invention that its utility, practicability and success, for the purpose for which it is intended, is actually demonstrated, or is capable of being demonstrated to those who see it. *Second*, if the party first to conceive and subsequently to reduce the invention to practice, does not use reasonable diligence in asserting his rights, and in the meantime the public derives a knowledge of the invention from other sources, or if by other inventors the public have been put in possession of the invention by public use or sale, he loses his rights. *Third*, when the burden of proof is upon a defendant to establish the date of his invention and patent, his proof must be of such a character as to be beyond all reasonable doubt. The rule is the same as against the plaintiff, when once the defendant, as in this case, has succeeded in shifting the burden of proof, by establishing beyond a reasonable doubt that some party other than the plaintiff's patentee, had, prior to the date of the patent, made the same invention. The burden of proof being thereby shifted, it becomes incumbent upon Weston and those claiming under him to adduce the most positive proof in support of his contention. Mr. Betts read from the opinion in *Thayer* vs. *Hart* (22 Blatchf., 229) which, he contended, applied precisely to the present case. He contended also that the evidence in behalf of Weston had proved nothing more, at most, than the performance of some abortive, inconclusive, and uninstructive experiment.

Mr. Betts next proceeded to analyze the patent in suit. He said that the preamble was almost exactly plagiarized from Sawyer and Man's English patent. Weston had nevertheless recognized the state of the art as shown in Despretz's experiments. He then read an account of Despretz's experiments, as published in the *Chemist* in 1849-1850, in which carbon rods had been electrically heated in a hydrocarbon atmosphere, and said that the statements of the experimenter showed precisely what the effect would be in all cases.

A careful perusal of the specification showed that it drew a distinction in the result or stated two different results; first, the filling up of the pores, rendering the carbon more dense and reducing its resistance, and second, building up the surface, or if irregular in diameter or resistance every part of the carbon is made of equal resistance or diameter. His Honor would find that the claim of the patent had been carefully limited to the process of "building up", and had moreover been so limited by the Patent Office. It was not for a general, but for a particular use of the process for building up the carbon. Next he would refer to the file-wrapper and contents and see what Weston's original claim was:—

The method of preparing carbon and conductor for incandescent lamps, by electrically heating them while surrounded by or saturated with a carbonaceous substance, as described.

His Honor would note that this was much broader than the claim which had afterwards been substituted, and had been made so in view of the publication of Despretz, which had been cited against it as an anticipation. He contended that this change materially narrowed the scope of the claim. Apparently the attorney had become satisfied that it was so broad he would not like to risk it, and so he had limited it to a process of building up imperfect carbons. The significance of that point was, that there was not one particle of proof that the defendant had ever utilized the process for building up imperfect carbons. All the witnesses had said it had been used "for drawing down resistance." The carbons were perfect—so perfect that the Edison Company to-day made all their carbons in this way without any treatment whatever.

The claim was for the treatment of carbon conductors *for incandescent lamps*. What force ought to be given to those last three words? The Despretz patents had been cited against Sawyer and Man. The English court had said:—"Yes, perhaps Despretz had described the same process; but it having been proved that Sawyer and Man had made a lamp, and had placed the carbon in it, had they not done something more?" Those three words must either be erased as superfluous, or they must be left in and a limiting effect given to them. If the patentee had never succeeded in making an incandescent lamp, how could he be said to have made a discovery or invention in incandescent lamps? He must show that he had successfully applied it in that way, yet the evidence had shown that he had not invented a practical lamp until 1881, and meanwhile Sawyer and Man had made lamps, and Maxim had made lamps, which were perfectly successful. It was not Weston who had done it. Those three words therefore "for incandescent lamps" had placed Weston in this dilemma:—If he claimed to have made the invention when he electrically heated the carbon in oil, he had made no advance on Despretz; or if he claimed to have been first in the use of the process as applied to incandescent lamps, then he was not the inventor, because in that respect Sawyer and Man and Maxim had both preceded him. The Sawyer and Man lamp had been fully described and illustrated at the time in the *Scientific American*. The difficulty with this lamp had been twofold. First it had not a filamentary carbon, which was necessary in order to achieve commercial success, and second, it was not an all-glass lamp. It had a metal base, which was subject to leakage. Nevertheless a test made by Stowell of the Sawyer-Man lamp had shown a life of 36 hours. This had been a reduction to practice, although the lamp had broken down from too much current. Mr. Betts then read from the *Scienticfi American* of March 8th, 1879, an article which, he contended, was a full disclosure of the process, two or two and half years before Weston had made his application. On the 14th of October 1878, Sawyer and Man had sold to the Electro-Dynamic Company a considerable number of patents together with the process in controversy, and the patent for the process had been assigned to the same company on February 3, 1879. What better evidence could there have been of the "sale" of the process more than two years prior to Weston's application? Mr. Betts read from the statute as to the effect of a prior sale, and asked what better evidence there could be of the "sale" of the thing patented than the fact that it had been sold. It was not material that they had not sold lamps. To manufacture and sell lamps required a large amount of capital. Newspaper articles had been published virtually offering the invention for sale. In connection with an invention of this class he knew of no better evidence that it had been "on sale".

The invention of Sawyer and Man had been embodied in a lamp so early that a patent had been granted in June, 1878. The defendants had met the obligation placed upon them by the rule of law and had shifted the burden of proof upon the complainants. Weston must now prove that he had made the invention in a fixed, positive and practical form, at an earlier date than Sawyer and Man. He would call attention to the fact that the complainant's evidence upon this point was exceedingly weak. Quimby was a patent solicitor and an expert, but there was not one word in his evidence about the making of an incandescent lamp. He had only said that the invention was useful for an incandescent lamp. Weston had never suggested to Quimby, so far as the record showed, that the invention was useful for incandescent lamps, nor had Mr. Quimby ever seen an incandescent lamp. Despretz thirty years before had done everything that Quimby saw. What was there that had advanced the sum of human knowledge one iota, in what Weston had shown Quimby? Then there was the evidence of Broadbent. Weston had not said to him that it had to do with incandescent lamps. Another significant fact:—Page, now one of the attorneys for the complainant had acted as Weston's attorney. In 1881 Page had only known him as connected with dynamo machines, arc lamps and plating apparatus. He would submit that Weston's contention was not consistent with the probabilities of the case. If Weston had ever done anything that he had regarded as of importance why should he not have communicated it to Quimby or to Page? Now they could appreciate the importance of the testimony of the witnesses which defendant had called in rebuttal. Huber, a man of great intelligence employed in the same establishment, had testified that he had seen nothing of the alleged invention nor had he seen any incandescent lamps. It was possible and even probable that he might not have seen a temporary or casual experiment, but his testimony had shown conclusively that there could have been no continuous experimentation nor diligent effort to reduce the invention to practice. The evidence had shown that Weston could not have made any invention which he himself had regarded as of any importance, for if he had done so his people all around him must have seen something of it. If he had done what he now says he had done, it was a matter too important to have been hidden under a bushel.

Again the dates were of great importance. There was no dispute as to what Sawyer and Man had done in March, 1878. It wouldn't do for Weston to say in a vague way: "I did the same thing in 1877." He must satisfy the court that there were good reasons for his saying that he had done this in 1877. A critical examination showed that he came very far from sustaining such an allegation, either by his own or by corroborative evidence.

As to the question of infringement it had not been proved that the invention had ever been used or had ever been sold by the defendant company. Mr. Betts read from Robinson on Patents, patent and other authorities, in support of the position that experimentation, merely in order to ascertain whether the process would really reduce the resistance of carbons, was not an infringement. No case of infringement had been made out.

Mr. Betts then reviewed the proof adduced in behalf of Sawyer and Man, and contended that it clearly showed that the public had been put in full possession of the invention and of full information in respect to the invention. Referring to the contention of the complainants that the exhibitions made by Sawyer and Man for purposes of display or for exploiting their electrical enterprises did not constitute the public use, Mr. Betts said that such a criticism came with peculiarly bad grace from those who sought to uphold Weston's invention. Surely Sawyer and Man had proceeded much farther than ever Weston had, for Weston had admitted that he had never made a lamp that lasted two hours. Sawyer and Man's lamp was very far from being as perfect as modern lamps, but it nevertheless was a great improvement upon its predecessors. The criticism that Sawyer and

Man's lamp never went into practical use, also came with bad grace from complainants. There had not been a particle of proof that Weston ever made a practical lamp until after it had been done by others. Maxim had commercial lamps in use in 1880. Sawyer and Man had long before that put the public in possession of the invention. The more the beauty and utility of the process became apparent, the greater became the improbability that Weston had made the invention. During the period referred to he had taken out 16 patents relating to other electrical inventions, and there was in them not one hint of a discovery of this kind. The testimony of three witnesses, his intimate associates, had been such as to preclude the possibility of any continued experimentation. It was impossible that these people should not have seen some evidence of such a discovery as complainants now claim.

Mr. Weston does not fix any date by himself or witnesses with sufficient accuracy to satisfy the courts of his priority. He has entirely failed to meet the requirements of the statute in that respect. Mr. Quimby's testimony that he saw the experiment in the basement of the "church" building, renders it important to know when Weston had his laboratory in that building. Weston fixes the date some time between the organization of the Dynamo Electric Company and his removal, and his memory, induced perhaps by his wishes, made him fix the date of his removal in 1878. The rent receipt, in the absence of any statement to the contrary, may be fairly assumed to have been for rent paid in advance, so that the date for removal cannot positively be put prior to October 1, 1878. The testimony of Quimby was very vague. He was favorable to Weston and he tried to fix the date in 1877, but was it reasonable to suppose that Quimby had any accurate recollection of the date when he saw the experiment? Would such evidence as his satisfy the obligation on the part of the complainant? He would submit that complainant had wholly failed to meet the burden of proof which had been laid upon them in this respect.

Mr. Weston had not regarded the invention as solely applicable to incandescent lamps. If he had been experimenting as a matter of scientific curiosity he had not gone beyond Despretz, for if there was any invention it must have lain in the application of the discovery to a practical purpose. Mr. Weston in 1877, had been a large manufacturer of arc light carbons. How was it that an invention useful in the very line of his business had never been so used, if he had actually made it? There was no explanation other than the explanation that Weston had never done anything at that time which he had regarded as important. Complainant must stand wholly on Weston's uncorroborated statement.

This process of treating carbons in oil or in gas evolved from oil, had never been practiced in a commercial way. The thing that was done in many incandescent lamp factories was the treating of the carbons in attenuated hydrocarbon gas, and this was found in Maxim's patent. The testimony of Vandegrift, or Shallenberger, and of Smith, all prove that carbons were always commercially treated by gas, so that it appeared that if the invention had been left where Weston has it nobody would have ever used it. It lacked the details which would render it of commercial utility. But Weston had described no apparatus for treating carbons in gas, much less in attenuated gas; on the contrary he had described a process which never had been used and was of no commercial value. Mr. Betts then commented further upon the evidence of Mr. Weston, and contended that he had wholly failed to make out a case entitling him to the favorable consideration of the court. Edison had patented a carbon filament lamp in January, 1880, and the court had declared him to be the inventor of the practical incandescent lamp. If Weston had made an incandescent lamp in 1877, why had he not been called as a witness in these important cases?

As to the question of what constituted "public use and sale," Mr. Betts said that he did not think what Maxim had done amounted to a public use and sale within two years. But as to Sawyer and Man, it was another matter. The cases which had been referred to by the other side were those in which the courts had dealt leniently with an inventor who had made his best efforts to put his invention in the market. But in the present case Sawyer and Man had certainly given to the public the fullest information in respect to their process There had been no secrecy about it. When the invention was a process, it was certain that nothing could more fully put the public in possession of it than the publication of a full description of it in the scientific journals.

Mr. Betts contended that the evidence showed conclusively that in his opinion awarding priority to Weston over Sawyer and Man, Commissioner Butterworth had overlooked the question of public use No such question had arisen as between Weston and Maxim, but he thought there was ground for holding that there had been abandonment on the part of Weston. All the time in which he had been doing nothing, other inventors had been at work, and had repeatedly described the invention in patents and in publications, and this he thought was sufficient to show that intervening rights had accrued. Despretz had certainly published what the result would be upon a carbon thread or rod heated to incandescence in a hydrocarbon atmosphere. He submitted that it made no difference what relation this had to the subsequent invention of others. The results of Despretz were in all substantial respects the results described by Weston. He certainly did not think that Weston was legally entitled to any patent for this invention.

RIGHT OF NEW STREET RAILWAYS TO USE EXISTING TRACKS.

THE Supreme Court of California, has disposed of the well-known case of the Pacific Railway Company et al. against Judge Wade of Los Angeles in an elaborate opinion. The public interest was incited by an argument for a writ of prohibition against Judge Wade to prevent him from assessing the amount of damages for and granting the right of way over the street cable road of the petitioners to the Los Angeles Consolidated Electric Railway Company. The gist of the decision is embodied in the following: "There can be no private property in a street, except the fee of the owner, which is held subject to the easement as long as the public continue to use the street as a highway. The maintenance of horse railroads and running of cars upon public streets of the city of Los Angeles for the carriage of passengers is a mere special mode of using the highway, nothing more. The right to maintain such a railroad does not exclude the public from using the street. The opinion therefore sustained the action of Judge Wade and held that the property of the petitioners is in custodia legis, and therefore the court can grant a right of way to any person or corporation and assess damages and compensation to be paid therefor, without citing or consulting the corporation, but simply upon the application of the receiver in possession of its property. The writ of prohibition against Judge Wade therefore was dismissed."

Literature.

Modern Practice of the Electric Telegraph: A Technical Handbook for Electricians, Managers and Operators. By Franklin Leonard Pope. Fourteenth edition. *New York. D. Van Nostrand Company,* 1891. *8vo. pp. xii,* 234. Price, $1.50.

THE first edition of Mr. Pope's useful and popular manual is dated 1869; a somewhat remote antiquity in electrical history. Telegraphy was then almost the sole electrical art of public significance, and some of its finer achievements were yet to come. The duplex was not yet commercially available, and the quadruplex had not arrived. In successive editions the author has kept "Modern Practice" fairly abreast with telegraphic progress, and in the case of this last edition the book is virtually rewritten and much expanded. The first edition had 128 pages; the thirteenth 160; while the book now has 234. In its original form it is familiar to most telegraphers of twenty years' standing; as recast and enlarged it well repays perusal by old acquaintances as well as by the younger men of the telegraph service. The well-ordered arrangement of numbered paragraphs and of chapters, characteristic of the first edition, has been preserved so far as the necessary introduction of new matter would permit. As before, the author has limited the scope of the handbook to the Morse signaling system, excluding type-printing, synchronous-multiplex, automatic, submarine and other methods. The duplex and quadruplex systems, now so widely employed, are amply and very lucidly described and explained; their principles of action are set forth with great clearness. A number of pages in chapter viii (Equipment of American Telegraph Lines) are given to the application of dynamos to telegraphy, a method of supplying current that has transformed the old-time battery-room of such a station as that of the Western Union Company in New York—with its endless rows and shelves of blue-stone batteries—into the semblance of a compact machine shop.

In no instance is the amplification of Mr. Pope's book more noticeable than in chapters iv, v and vi of the new edition, which treat upon the theory of electrical measurements, the laws and conditions of electrical action and of electro-magnetism. These topics, which scarcely entered the thoughts of American telegraphers a generation ago, and which were allowed but a meagre space in the early editions of "Modern Practice" (the first of which appeared but a year or two after the introduction in America in a small and tentative way of systematic line testing), are here treated with a fulness quite adequate to the requirements of those engaged in our now greatly improved telegraph service. The theoretical and technical points are perspicuously set forth in relatively simple but accurate language, the nomenclature being adapted to the best existing usage. There is also included due reference to the more recent views and speculations as to the nature of electricity. The author's cleverness in illustrating his descriptions and expositions is manifest in the many drawings and diagrams employed throughout the book. They are not only truly illustrative of the text, but in appearance are quite worthy of the fine typography and handsome make-up of the book.

A special word should be said in praise of the consideration for readers shown by an author who takes pains to provide so ample and useful an index as that given by Mr. Pope in his last edition

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED DECEMBER 15, 1891.

Alarms and Signals:—

Electric Signaling Apparatus, G. E. Miller, 464,979. Filed Apr. 3, 1891.
An electric signaling apparatus for railway trains.

Conductors, Conduits and Insulators:—

Electric Conductor, W. E. Oehrle, 464,986. Filed Sept. 14, 1891.
An insulated conductor for electric light wires.

Coupling for Electric Conductors, W. C. Preston, 465,202. Filed Apr. 27, 1891.
Consists of a short tube adapted to hold the ends of the conductors snugly, the conductor being held in place by wedges driven into an opening in said tube.

Electric Connector, W. F. Z. Desant, 465,430. Filed May 20, 1890.

Dynamos and Motors:—

Dynamo-Electric Machine, W. P. Wiemann, 465,104. Filed Dec. 30, 1890.
A dynamo comprising metallic end plates carrying rigid field-magnet cores, a magnetizable iron mass carried by the shaft extending through said field cores, the exciting coils wound on the field-magnet cores and the armature having its cores provided with pole pieces which form multiples of the polar projections on the iron mass.

Commutator Connection for Dynamo-Electric Machines, C. O. C. Billberg, 465,233. Filed Oct. 7, 1890.
Provides means for readily detaching the armature wires from their commutator strips for purposes of repair, etc.

Brush Holder for Dynamo-Electric Machines or Motors, C. O. C. Billberg, 465,234. Filed April 25, 1891.
Has for its object to maintain a proper bearing of the brush at all times upon the commutator.

Switch-Actuating Mechanism for Electric Motors, C. G. Armstrong, 465,401. Filed May 11, 1891.
Relates to construction of devices for stopping and starting electric motors.

Electric Motor Switch, E. W. Rice, Jr., 465,292. Filed Mar. 28, 1889.
Has for its object to prevent damage to the electrical apparatus from a sudden heavy flow of current.

Electric Motor, H. Groswith, Reissue 11,210. Filed Oct. 26, 1891.
An electric motor having a duplicate set of elements, a common external connection to one brush of each commutator and a pair of contacts connected respectively to the two other brushes for external connection.

Galvanic and Thermo-Electric Batteries:—

Packet or Pad for Electric Batteries, L. H. Rogers, 465,206. Filed Feb. 20, 1891.
Consists in enclosing an electrolytic chemical within an envelope of porous material.

Lamps and Appurtenances:—

Portable Electric-Lamp Holder, J. Baker and H. S. Graham, 465,039. Filed Mar. 5, 1891.
Provides means for lengthening or shortening the conducting wires of an incandescent lamp.

Measurement:—

Electrical Indicating-Instrument, E. Weston, 465,442. Filed Mar. 11, 1891.
An ampere meter in which the fixed coil is eliminated and the movable coil is closed in the annular field produced between the poles as a permanent magnet.

Metallurgical:—

Process of Extracting Copper Pyrites, T. A. Edison, 465,250. Filed Feb. 17, 1890.
Claim 1 follows:
The method of concentrating chalco-pyrites ores by eliminating magnetically any magnetic material therein, while the copper and iron pyrites are non-magnetic, and then heating the remainder to such a temperature as to render the chalco-pyrites magnetic and separating the reduced chalco-pyrites magnetically.

Magnetic Ore Separator, C. M. Ball, 465,349. Filed Dec. 11, 1890.

Medical and Surgical:—

Electric Belt, A. Erikson, 465,093. Filed June 25, 1891.

Miscellaneous:—

Means for Propelling Boats by Electricity, O. Büsser, 464,955. Filed Feb. 10, 1891.
Relates to a method of towing canal boats by means of an electric motor on the deck of the boat, acting on a stationary cable sunk in the canal, and a trolley wire strung along the bank of the canal.

Automatic Circuit-Breaker, W. R. McLain, 465,046. Filed Sept. 18, 1890.
Has for its object a method of automatically increasing the break in the circuit at the instant of the melting of the fuse wire.

Riveting by Electricity, E. E. Ries, 465,089. Filed Sept. 15, 1888.
See Patent Notes.

Feed-Water Regulator, G. W. Schilling, 465,212. Filed Jan. 27, 1891.

Method of Controlling Alternating-Current Induction, E. Thomson, 465,-078. Filed Apr. 17, 1889.
Consists in varying the angle of the magnetic axis of two coils in inductive relation to a closed magnetic circuit.

Adjustable Rheostat, F. J. Sprague and C. R. Pratt, 465,218. Filed Aug. 25, 1891.
A rheostat having a large number of contact plates in the switch by means of which the resistance is varied, said plates being so mounted as to occupy a small space and provide a rapidly-moving co-operating contact.

Electrical Sewer-Gas Indicator, J. J. Lawler, 465,278. Filed Mar. 4, 1891.
An electric signal for sewerage systems.

Electric Fan, P. Diehl and E. H. Bennett, Jr., 465,360. Filed Apr. 4, 1891.

Electric Fan, P. Diehl and E. H. Bennett, Jr., 465,361. Filed Apr. 8, 1891.
A novel arrangement of suspended ceiling fan.

Bracket for Supporting Electric Conductors, J. A. Duggan, 465,365. Filed July 15, 1891.

Production of Insulating Coatings or Linings in Electrolytic Apparatus, L. Grabau, 465,309. Filed Aug. 9, 1887.
A melting pot having a cell surrounding an electrode, the cell being open at the bottom and having double walls forming a chamber provided with a feed and exhaust port and a discharge passage connected with the neck of the cell for the discharge of the matter.

Electric Heater, W. H. Boles, 465,423. Filed Mar. 21, 1891.

Electric Switch and Case for the Same, C. P. Chappell, 465,425. Filed Nov. 4, 1891.
Method of protecting the contact plates of switches from exposure to the weather.

Mining Machine, J. C. Werner, 465,150. Filed May 11, 1891.
Claim 1 follows:
The combination of two rotary cutter bars and an intermediate rotary clearing-worm, the cutter bars operating independently of each other and of the worm.

Railways and Appliances:—

Electric Car-Brake, E. Verstraete, 465,034. Filed Feb. 5, 1891.

Converter System for Electric Railways, M. W. Dewey, 465,359. Filed May 11, 1891.
Provides cores for the primary or road-bed coils that will form and maintain closed magnetic circuits.

Train-Signaling Apparatus, P. Synnestvedt, 465,396. Filed April 27, 1891.
An electrically operated compressed air or steam train signal.

Electric Railway, G. F. Green, 465,407. Filed Sept. 15, 1879.

Electrical Railway, G. F. Greene, 465,432. Filed May 15, 1886.
See Patent Notes this issue.

Telephones and Apparatus:—

Telephone, C. Cuttriss, 464,959. Filed July 22, 1891.
A telephone receiver without electrodes. See THE ELECTRICAL ENGINEER Dec. 16th.

Patent Notes.

E. E. RIES' PATENT ON RIVETING BY ELECTRICITY.

ON Dec. 15 a patent was issued to Mr. E. E. Ries, of Baltimore, entitled "Electric Riveting," No. 465,089. This patent describes the process in which the rivets are inserted in the holes in a cold state, which are then heated to incandescence by the passage of an electric current through the same and are maintained at incandescence during the operation of heading, by which the operation of riveting is greatly facilitated. The patent contains seven claims, of which we give the three following:

1. The method or process of riveting which consists in heating the rivet when inserted in the rivet hole or holes by the passage of an electric current through the same and then heading the rivet, substantially as described.

3. The method or process of riveting which consists in heating the rivet when inserted in the rivet hole or holes to the required degree of incandescence by the passage through the same of an electric current of suitable quantity and tension, then heading the rivet and maintaining the same in the desired state of incandescence by suitably regulating the current during the heading operation, substantially as described.

5. The method or process of riveting metal structures together, which consists in first inserting a rivet into the rivet-hole, then making electrical contact between the ends of the rivet and an anvil and the heading-die, respectively, which constitute the terminals of an electric circuit, then charging said circuit with an electric current or currents until the rivet is heated to the desired degree of incandescence, and then forcing the heading-die upon the rivet until the heading operation is completed, substantially as described.

GREEN'S ELECTRIC RAILWAY PATENTS.

CONSIDERABLE interest has been manifested in the issuance of two patents to George F. Green, of Kalamazoo, Mich., as they date back to the early days of electric railroading and were the subject of prolonged interference proceedings. The patents are entitled "Electric Railway," Nos. 465,407 and 465,432, December 15, 1891, and were filed respectively September 15, 1879, and May 15, 1886.

Claim 4 of the first patent is follows:

The combination of a railway track, one or more stationary means of electric supply, electrical conductors extending from said means of electric supply along the lines of said track, and consisting wholly or in part of the rails thereof, vehicles moving along said track, rotating electro-dynamic motors fixed upon said vehicles for imparting motion thereto, and wheels supporting said vehicles upon the track, and also serving to maintain continuous electrical connection between said means of electric supply and said rotating motors, substantially as described.

Claim 3 of the second patent is as follows:

The combination of one or more sources of electric supply, a railway track, a wheeled vehicle moving upon or along said track, a conducting circuit composed wholly or in part of insulated conductors extending along the line of travel of said vehicle, one or more rotating electric motors mounted upon said vehicle for propelling the same and included in said circuit of conductors, and a circuit controller placed on said vehicle, and also included in said circuit of conductors, substantially as described.

It is claimed that Mr. Green conceived his invention long prior to the filing of his patent, and that he built and operated a small model as far back as 1874, for the purpose of exhibiting his invention to capitalists and demonstrating its practicability.

ELECTRIC SMELTING—COWLES CO. vs. PITTSBURGH REDUCTION CO.

THE Cowles Electric Smelting Company has filed a bill in equity in the United States Court, Cleveland, O., against the Pittsburgh Reduction Company. The bill asks for an injunction preventing the defendant company from using certain patents for smelting ores by electric currents, claiming priority for the invention and patent. It is similar to a suit filed by the Pittsburgh Reduction Company against the Cowles Company in the Cleveland courts, and is only another chapter of the bitter fight which the two companies are waging against each other.

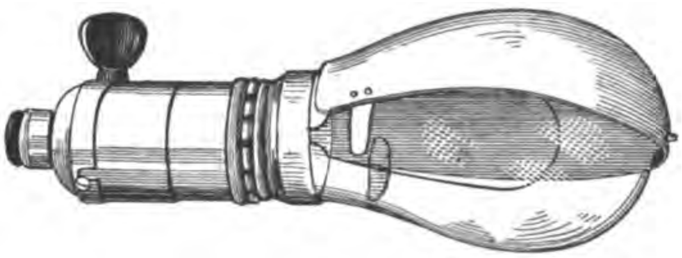
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Interest the public in your business by advertising its facts.

THE NOVELTY ELECTRIC CO.'S HALF REFLECTOR.

A NUMBER of interesting novelties and new designs in electric light fixtures and supplies have recently been brought out by the Novelty Electric Co., 50, 52, 54 North Fourth Street, Philadelphia. One of these, illustrated herewith, is their "No. 1 Half Reflector." It is a simple and efficient device, and very reasonable in price. The half-round reflector springs at once into position on the glass



NOVELTY ELECTRIC CO.'S HALF REFLECTOR.

bulb of any incandescent lamp, and a small hole at the lower end of the reflector engages with the little projection or "nipple" at the tip of the lamp. These reflectors are made in a variety of forms and admit the use of the ordinary shade at the same time.

BURTON ELECTRIC HEATERS.

THE Electric Merchandise Co., Chicago, has received this week an order for four sets of Burton electric heaters from the Aspen Mining Company, Aspen, Col., to be used in the company's motor stations. The Benson & Halcyon Heights Railroad Company, Omaha, Neb.; Edison General Electric Company, Portland, Ore.; Maschinenfabrik Oerlikon, Oerlikon bei Zurich, Switzerland; Newburyport & Amesbury Horse Railroad Company, Newburyport, Mass.; Warrensburg Electric Light Company, Warrensburg, Mo., are among the number of companies placing recent orders for heaters. The following letter has been received:

ALLENTOWN AND BETHLEHEM RAPID TRANSIT CO.
Allentown, Pa., Dec. 10, 1891.

BURTON ELECTRIC CO.,
Richmond, Va.

DEAR SIRS: Please ship eight more electric heaters with switches, being the equipment for two cars same as we had before. They are giving excellent satisfaction and are liked by the patrons of the road much better than the stoves.

Yours truly,
(Signed) A. H. HAYWARD, Sup't.

WALDO & STOUT.

THIS firm has just been organized at Bridgeport, Conn., for the purpose of embarking in the business of founders in aluminum, silicon and manganese bronze. The firm consists of Dr. Leonard E. Waldo, who is well known to the electrical profession from his work in the perfection of aluminum and silicon bronzes. Mr. Newton E. Stout will have the care of the business management.

The new foundries of the firm will be located on Railroad avenue extension, near the Wilmot & Hobbs factories, and a new road will at once be opened to that thoroughfare. The foundries will be devoted to making new alloys of copper with aluminum, silicon and manganese in the shape of bronze and brass castings. The design of the furnaces is the Swedish patent furnace for casting wrought iron, and oil will be used as fuel. It has also been decided to erect very complete facilities for the proper testing, both chemical and physical, of the metal for engineering or other purposes. Among other things a contract has been made for the construction of a testing machine to break bars up to a tensile strength of 200,000 pounds.

The new company hope to get their first building completed by early summer. Their structures will be spread over an acre of land, and additions will be erected over the rest of the site as the work extends. The buildings will be constructed of brick, and on account of the use of oil as fuel the roof in the centre will be about fifty feet from the ground. Two acres more are held in reserve for future buildings. Mr. Erwin S. Sperry will act as superintendant of the factory.

ALEXANDER, BARNEY & CHAPIN.

THIS enterprising firm have been compelled for the third time since the establishment of their business, to enlarge their store to keep pace with their ever-increasing trade. They had to abandon the "Exchange" and tear down the offices formerly used by the purchasing agent and general sales agent, and add all that part to their store. New shelves and counters have been put up, and they have thereby not only gained a great deal of room, but the appearance of the store seems to be improved.

Among the many novelties shown at their establishment for the holiday season is a Christmas tree lighted by miniature incandescent lamps, which is attracting a great deal of attention in their window. It is seldom that a handsomer show is made during the holidays than that displayed by the A. B. C. Co. at the present time.

GAS ENGINES AND DYNAMOS FOR ISOLATED PLANTS.

ONE of the exhibits that attracted a great deal of attention at the American Institute Fair was a complete isolated plant composed of a 2 h. p. Hartig improved gas engine and a 16-light Riker low speed dynamo. The gas engine having two cylinders gets an impulse at each revolution, thus obviating any flicker in the electric light. The dynamo is compound wound and has a 10-inch pulley driven from the 44-inch fly-wheel on the gas engine. It runs at the low speed of 810 revolutions per minute, the gas engine making 185 revolutions per minute. The extremely low speed of the dynamo has also a great deal to do with the steadiness of the lights.

Below will be seen a table showing the actual amount of gas consumed per hour and cost for a specified number of lamps. This plant took the award of excellence at the fair.

Mr. Hartig does not claim the highest efficiency for his engine, but guarantees it to run at a more uniform speed than any other machine in the market.

Num. of 16c. p. 110 volt lamps.	Volts.	Speed.	Gas consumed in cubic feet.	Cost per hour gas @ 1.25 per M.
16	110	810	80	10 cts.
12	110	820	60	7.5 cts.
8	110	830	52	6.5 "
4	110	840	44	5.5 "

Running free the engine consumed 20 cubic feet of gas.

THE UNITED STATES PORTELECTRIC CO.

ARTICLES of incorporation of the United States Portelectric Company, with a capital of $5,000,000, were forwarded from New York to West Virginia last week, the company having been organized under the laws of that State. The following are the incorporators: Thomas L. James, ex-Postmaster General; ex-Judge A. J. Dittenhoefer, John Straiton, Charles F. James, Percival Knauth, William James, John T. Williams, Colonel Henry Huss, Frank Lawton, and Whipple V. Phillips. The company controls a device for the transportation of mail and express packages at a high rate of speed, which, it has been reported, will probably be utilized by the Post Office Department. There has been an experimental plant in operation in Dorchester, Mass., for the past year. The *modus operandi* was illustrated and described in THE ELECTRICAL ENGINEER, May 27, 1891.

A CHRISTMAS TREE TWIG.

THE American Electrical Works have long had the reputation for taste and ingenuity in the little souvenirs they send their friends from time to time. The latest of their productions in this line is a pretty Christmas card, bearing a twig from their Christmas tree, associated with the usual good wishes of the season and the sentiment: "Heaven give you many, many merry days."

TO MANUFACTURE THE FIBROUS BATTERIES.

We have received information that the Fibrous dry battery and the disque Leclanché porous cup are hereafter to be manufactured exclusively by Messrs. Thompson & Robertson, 258 Broadway. This battery and cup, it will be remembered, have been manufactured for some time past by Messrs. Taylor & Walsh, of this city, whose interest the firm of Thompson & Robertson have purchased. The first-named member of this firm is the Hon. Roscoe H. Thompson, formerly of Boston, and the late treasurer of the Fibrone Manufacturing Company, of this city. Mr. J. Hart Robertson, under whose supervision the batteries will be manufactured, is a member of the New York Electric Club, and a well-known electrician, the most prominent of his inventions probably being the writing telegraph. Mr. Robertson, however, considers the fibrous battery the most promising of his inventions, and will give all his time to its manufacture at the company's factory in Bloomfield, N. J. Mr. Louis Walsh will be the manager of the sales department. Mr. Walsh is probably best known to the electrical trade through his connection with the Crosby Electric Company, of this city. The Fibrous dry battery is adapted for all open-circuit work, is small, being only 4¾ x 8 inches, and cylindrical in shape, and is said to be the only dry battery in the market that is not sealed. The company have already received many flattering testimonials in regard to this battery.

E. T. BIRDSALL, M. E.

Mr. E. T. Birdsall, of 115 Broadway, has been retained as the consulting engineer for the new Hotel Grenoble, a fine building to be put up by the well-known builder Noble. Mr. Birdsall will have charge of all the mechanical and engineering details, and will put in a fine electric light plant of about 1,200 lights. He has also been retained for the big new Municipal Building on Centre street, which will be at least two years before it is completed. Mr. Birdsall has of late had many calls of this nature upon his time.

PHILADELPHIA NOTES.

Mr. Chas. K. Westbrook, manager of the Isolated Light and Power Department of the Thomson-Houston Electric Light Co., announces the following recent sales and installations, viz.: Philadelphia and Reading Coal and Iron Co., Pottsville, Pa., 35 arc; Pencoyd Iron Co., Pencoyd, Pa., 50 arc; H. C. Hamilton & Son, Manayunk, 500 incandescent; So. Baltimore Car Works, Baltimore, Md., 35 arc; B. and O. Railroad Co., Brunswick, Md., 25 arc; Delaware Hosiery Co., Dover, Del., 250 incandescent; Penn. Supply Co., Wilkesbarre, Pa., 90 incandescent; Stinson Bros., Philadelphia, 45 arc; Cayuta Wheel Foundry Co., Sayer, Pa., 125 incandescent: Boyd, White & Co., Philadelphia, 18 arc; Shoneman & Bros., Eighth street, 6 arc; and a 75 incandescent plant for use on the boat of the Board of Police Commissioners at Baltimore, Md.

The Car Shops of the Bristol (Tenn.) Belt Line Railway Co., of which Mr. W. A. Stadelman of this city is general manager, were completely destroyed by fire last week, together with cars, motors, tools, etc., and are supposed to have been set on fire by tramps after having killed the watchman, Mr. John Overstreets, whose body was found in the ruins burned to a crisp and surrounded by four iron barrel hoops. The company has placed an order with the J. G. Brill Co. for new cars, and the road will soon be put in operation again. The road was of the Short system and had only been in operation about two months.

Vallee Bros. & Co. have this week completed the contract for wiring the Williamson Free School, which has been progressing for over a year. This firm have for several months confined themselves strictly to the electrical supply business, but the above contract was taken before the construction work was abandoned. They are agents for the Buckeye incandescent lamp, of which they have sold over ten thousand this fall. The agency for the Russell mast-arms has recently been awarded this firm.

La Roche Electric Co.—At a meeting of the board of directors of the La Roche Electric Works, last week, it was decided to build a factory for the manufacture of their electrical apparatus. A committee was appointed to select a desirable site which will be suitable for shipping facilities. This move was made in order to meet the large increase of business, which has outgrown the capacity of their present quarters.

The Century Electric Club has just been organized in this city for the advancement of its members in the electrical field, in which they are all engaged. The work will consist in reading papers, etc., discussions, and a regular review of periodicals.

"Star Electrix." The irresistible Mr. D. C. Spruance, of the Star Electrix Co., is home for the holidays from the West and reports the largest crop of orders ever known by the oldest inhabitants.

Curtis Bay, Md.—I was in error last week in stating that Mr. W. A. Stadelman had closed a contract with the Curtis Bay Railway Co. of Baltimore. It should have read Mr. W. A. Stearns, of the Edison Co.

Mr. M. S. Shapleigh, agent for the Electrical Supply Co., reports a large increase in business over last year. They have just put upon the market several new specialties which have merit.

Mr. S. Ashton Hand, vice-president of the Equitable Engineering and Construction Co., has gone to Chicago and other points West on a business trip.

Mr. C. A. Benton, of the Detroit Electric Works, was in the city last week on business, and took wing northward for New York.

WESTERN NOTES.

The Electric Appliance Company, as general Western agents of the Consolidated Electric Manufacturing Company, of Boston, are putting in a very large stock of their celebrated goods. Their sockets, wall sockets and receptacles are samples of the manufacturer's art. Their Davis arc light cut-out has been demonstrated as being a wonderfully practical article, and is used exclusively throughout Boston by the Boston Electric Light Company. Their arc light hanger boards, switches, etc., are very desirable articles at attractive prices. Their telescope switchboard plug and socket, with auxiliary transfer plug, fills a long-felt want. The Electric Appliance Company is certainly to be congratulated upon securing control of so valuable a line of specialties.

The Laclede Gas Light Co., St. Louis, will double the capacity of its incandescent electric lighting plant, and has ordered of the Pond Engineering Company, two 250 h. p. compound condensing Armington & Sims engines, with Blake pumps, and independent condensing apparatus. This work was awarded, after strong competition from all the leading high-speed engines, to the Pond Engineering Co., who will put in the foundations, and superintend the installation and starting of the plant. It is expected that one of these engines will be in operation by Jan. 1st, 1892, and the other shortly thereafter. The first engine will be belted direct to a 2,500 light alternator. The foundations will be carried to solid rock.

The Electrical Supply Co., Chicago, have converted the front end of their large store into an elegantly finished sample-room. This is separated from the sales department by a combination of handsome upright display cases and a beautifully patterned grille reaching to the high ceiling. All the woodwork is oak, finished in hard oil. The floor is of the same material, laid in mosaic figures, oiled and polished. Displayed in the cases and arranged about the room are samples of every conceivable article for electrical use. To such an extent has this been carried that the display amounts to a small exposition in itself. No visitor to Chicago should fail to see it.

The Patton Motor & Mfg. Co. are receiving inquiries from street railway men from all over the country in regard to their street railway system, recently described in The Electrical Engineer, some of which are highly interesting. They are building two complete outfits with the utmost dispatch, and which will be shipped to their respective destinations in a short time. Their car at Pullman is still running day in and day out with the same persistent regularity and refusal to break down under all the severe tests to which it has been subjected.

Mr. J. K. Pumpelly is busily employed in developing his new mechanical form of storage battery, in which he has not only made important changes from any heretofore made, but which, it is stated, does not infringe on any of the storage battery patents. His plant is located at No. 205 Springer Building, and he will shortly place these new cells on the market.

Mr. C. O. Harris, of Dallas, was in town last week looking after a number of standard articles which he will handle in Texas and the neighboring States. As a member of the late firm of Clower, Harris & Co. he built up quite a trade for supplies, and will no doubt find a ready market for the class of goods which he will offer.

The Chas. Munson Belting Co., through Mr. H. B. Morgan, have secured the order for the belting for the L. Z. Leiter Building, comprising two 48 inch, seven 10 inch, two 12 inch and one 6 inch belts. This is the largest private electric plant in the city of Chicago.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

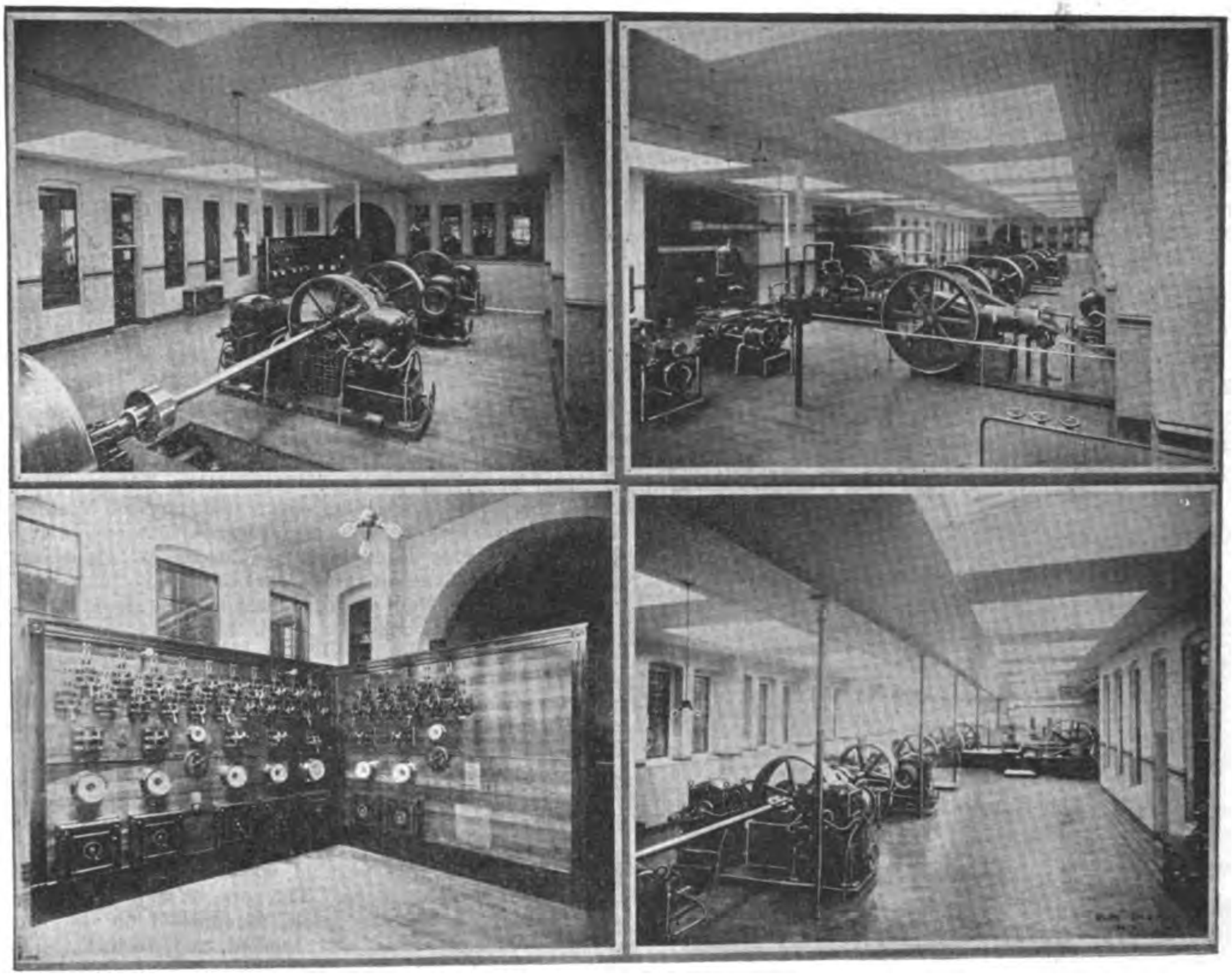
THE
Electrical Engineer.

VOL. XII. DECEMBER 30, 1891. No. 191.

LIGHTING THE WALTHAM WATCH FACTORY.

SOME three years ago the Waltham watch factory, at Waltham, Mass., after having experimented with several systems of electric lighting, concluded to put in a large isolated plant, and upon careful investigation placed the order with the Mather Electric Company, through Claflin & Kimball, their New England agents, for a plant of 2,000 lights. This plant, Figs. 1, 2, 3 and 4, was installed originally in the summer and fall of 1888, and has since been increased by the further addition of 1,250 lights dynamo capacity. They have already connected nearly 5,000 lights through the various departments of their extensive works.

The dynamos supplied by the Mather Company are of the Anthony type, whose special feature lies in the construction of the field magnets, which are constructed of laminated wrought iron of very thin plates, the magnet being stamped out of wrought iron, and thus composing a field without any joints in the entire magnetic circuit. In this way the high efficiency of the Mather dynamo is retained, together with a gain in decreased weight of the machines and slow speed of the dynamos. The dynamos have a capacity of from five to six hundred lights each, running at a speed of about eight hundred revolutions per minute.



FIGS. 1, 2, 3 AND 4.—MATHER ELECTRIC LIGHT PLANT, DRIVEN BY EVANS FRICTION SYSTEM, WALTHAM WATCH CO., WALTHAM, MASS.

The switchboard arrangements of the plant, Fig. 3, are very complete, and include a full set of instruments for each dynamo, the whole being so arranged that the dynamos are run in multiple, the dynamos being switched into circuit as the current is called for throughout the building. Each department of the building, thirty-two in number, is supplied by an entirely separate circuit from the dynamo-room, thus placing the lights of any of the departments of the building under the control of the electrician in the dynamo-room.

It was the original intention when the plant was installed to use storage batteries as an auxiliary to the dynamos, and a storage battery plant of a capacity of 500 lights was originally installed, but its use has been gradually superseded by the use of dynamos, as the batteries do not appear to be entirely suitable for the purpose for which they were used.

As will be seen from the cuts, the dynamos are driven by the Evans friction system, driving direct from the main shaft. This system gives easy control of the individual dynamos, allowing them to be started and stopped at will without the use of friction clutches. The dynamos are so arranged that they may be driven either from the main shaft from the main engine of the Corliss type, or they may be driven direct by means of a Ball compound engine of 300 h. p., which is shown in Fig. 3.

As an auxiliary to the regular dynamo plant, a small dynamo of 250 lights capacity has been installed for the purpose of furnishing light during the night for watchmen purposes and for sweeping the factory, every foot of the immense establishment being swept every night.

This plant has been very satisfactory to the Waltham Watch Company, and has reflected great credit on the work of the Mather Electric Company and its agents, Claflin & Kimball. When it is remembered what a particularly perfect service is required in the delicate work of watchmaking, it can be easily understood that a system that is satisfactory for such work must be entirely satisfactory for any of the ordinary classes of manufacturing. This we believe to be one of the best, if not the best, and largest isolated plants for manufacturing purposes run as a plant from one point. It has operated now some three years without a single breakdown or interruption of service of any kind.

THE WADDELL-ENTZ ELECTRIC MOTORS AND DYNAMOS.

THERE was a time, not many years ago, when the designing of dynamos and motors was in the hands of that

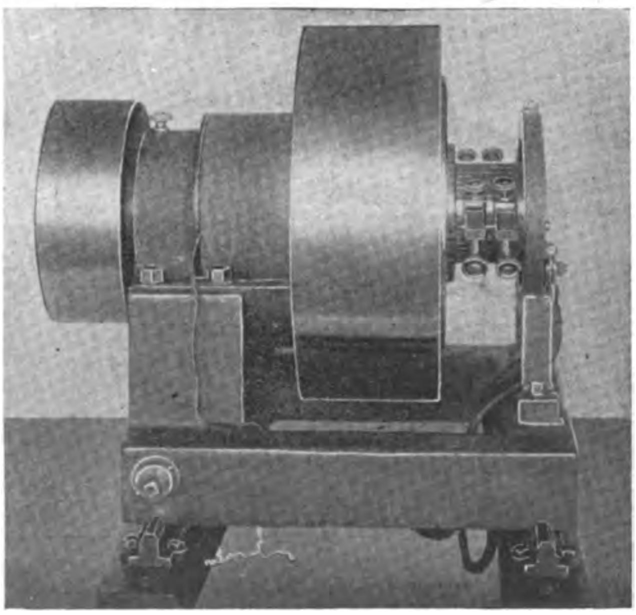


FIG. 1.—THE WADDELL-ENTZ DYNAMO.

class known by the generic term of "inventor," whose chief aim seemed to lie in the direction of constructing machines not with the view, particularly, of obtaining the highest results, but of working out a design which should differ as far as possible from that of all other existing machines. This practice has fortunately gone very largely out of fashion, and in its place we find the efforts of designers bent in the direction of constructing machines

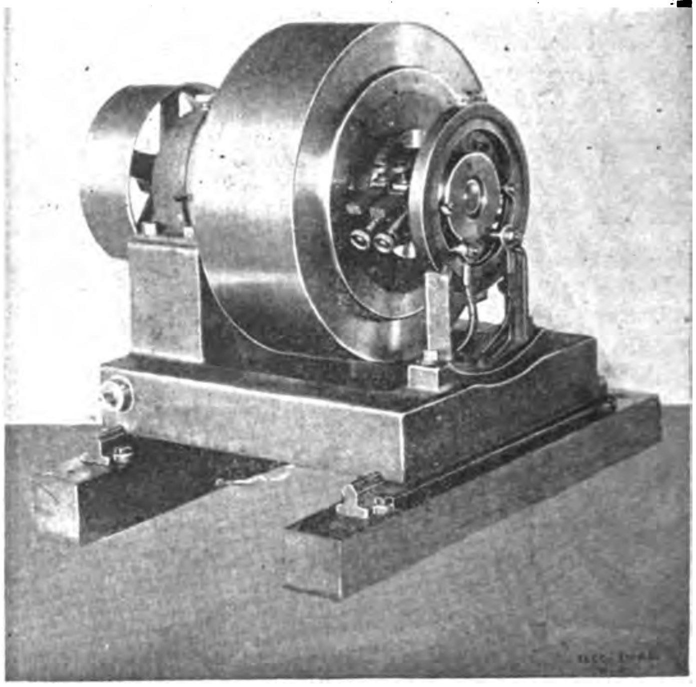


FIG. 2.—THE WADDELL-ENTZ DYNAMO.

which shall be not only of very high electrical efficiency, but in which the design is such that the machine can be produced with the least possible cost. A good example of this modern tendency is to be found in the design adopted in the machines now being constructed by the Waddell-Entz Electric Co., of this city, and our readers will be interested in the description of the means which have been employed to effect the desired purpose.

The machine which we illustrate in the accompanying engravings has a capacity of 2 kilowatts, and in its design Messrs. Waddell and Entz have had in mind constantly, first, the securing of high electrical efficiency with a mechanical construction such that the parts should be subject to the least manipulation and machine work. It was for these reasons that the type of field and armature shown was adopted. As will be noted, the field magnets are energized by a single coil wound upon a core which has a projecting horn which forms the upper pole piece. This core is let into a hub, which has a low projecting flange running parallel with the core, and which forms the lower pole-piece. The core, as well as the outside surface of the pole itself, is finished on the same mandrel, and is bored and bushed, and turned at the end. The energizing coil is slipped on to the core, which is held in place securely by two screws which prevent it from turning and at the same time from slipping in and out. The core is of malleable iron, and, as already stated, is bushed, and forms the bearing for the armature shaft. In order to provide for ample oiling the magnet is cored, thus providing an oil chamber; at each end of this core a ring passes over the shaft and dips down into the oil below, so that as the shaft revolves a continual supply of oil is fed to the bearing. As a result, the machine requires no attention in this regard for weeks at a time. In the larger machines having four or more poles a second bearing is provided, but in the two-pole machines, as stated above, the armature is entirely supported by a single long bearing passing through the centre of the magnet core.

The construction of the armature adopted in this machine has been very carefully worked out, and a somewhat striking feature of the machine is the fact that no wire whatever is visible, the armature being inclosed in a brass cover. The armature is built up of soft iron rings stamped in a press, and one of its principal characteristics lies in the fact that it is built up and held in position without the employment of bolt holes passing through the armature. By this design the full section of the iron is utilized, which is particularly desirable in multipolar machines. The rings, insulated by paper, are perfectly smooth, and require no turning in the lathe after they come from the stamping press. For the purpose of building up into an armature they are put into a press between two outside rings of brass, and are then screwed up under pressure. spider is bolted to the armature ring by means of the same bolts which serve to bind the armature plates together, and the brass cover is then slipped over the armature and held in place by screws. By the employment of the bolts on the outside of the armature not only is the reduction of the magnetic circuit obviated, but, in addition, the insulation of the plates from one another is not destroyed, as has frequently been proved to be the case of the bolts passing through, and which therefore require to be insulated and thus serve to still further increase the size of the hole and thus reduce the iron section.

As the pole-pieces are situated entirely on the inside of the ring, all trouble due to shifting of the wires by centrifugal force is avoided, as the revolution of the armature merely tends to keep the inside of the wire more firmly in place; besides, the action of the magnetic lines is such as to make the wire hug the armature more closely.

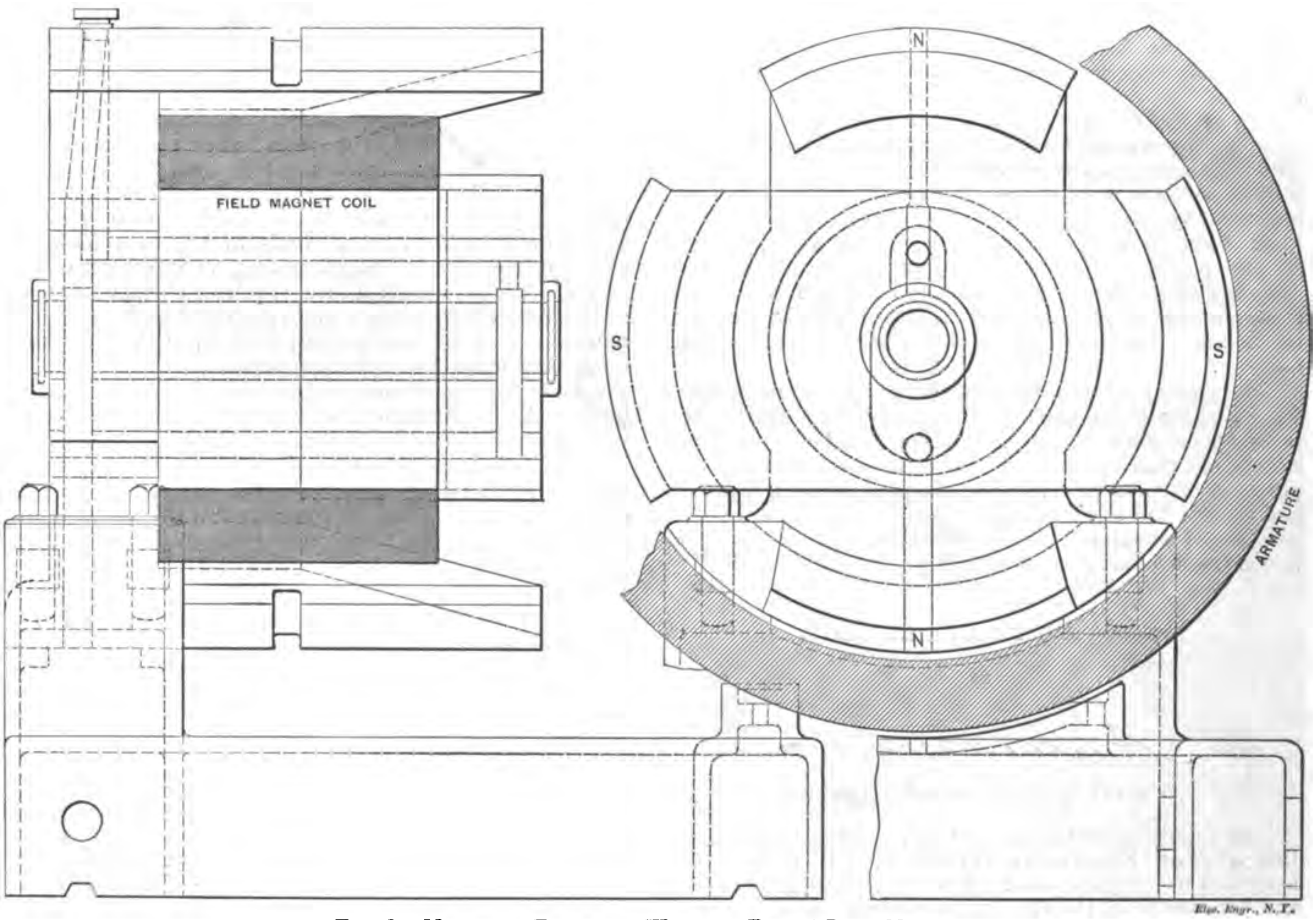


Fig. 3.—Magnetic Frame of Waddell-Entz 4-Pole Machine.

The outer brass rings are then clamped together by a series of bolts spaced evenly around the armature and screwed up by nuts while the plates are under pressure, so that when the pressure is released the armature comes out as a solid ring.

The bolts encircling the armature are placed on the outside circumference, leaving the inner entirely smooth, and are of small diameter, being so spaced that they form grooves for the winding. They thus afford a positive driving and take the place of teeth without, however, introducing disturbing reactions. They also avoid the slotting of the armature and thus can be stamped out with a smooth, round die. The armature is therefore practically ready to wind as soon as it comes out of the press, so that the least possible time is lost. While this operation is going on, the commutator is being built up upon the spider through the center of which passes the shaft. When complete, the

In the two-kilowatt machine illustrated, the brushes are held by a stand encircling the end of the commutator. Each pair of brushes is mounted on a separate ring, these rings being insulated from each and held in position in the frame. The machine is so designed that the brushes, once set, require no shifting, the machine being sparkless at all loads.

The machine, it will be noted, is mounted on a pair of rails, and for the purpose of tightening the belt a screw passes through a threaded eye cast into one of the rails. By this means, while being shifted to and fro, it is at the same time positively held in position and its stability thus increased. The machine work required in the building up of these dynamos, it will thus be noticed, consists almost exclusively of boring and turning, the only planing necessary being that required for the rail grooves. On account of the design adopted, it will be seen that each part of the machine can be separately constructed, the armature being independent of the commutator and spider, and each of the magnetic parts also is capable of separate finishing. The result is that the machine can be constructed in the least possible time as no one part need be delayed while another is being finished, a most desirable feature in the rapid filling of orders.

The design of the frame of the four-pole machine is illustrated in Fig. 3. Here, it will be seen, a single energizing coil is also employed, but an outer bearing is added to give stability to the armature.

These machines are built in sizes varying from 2 to 100 kilowatts. In the two-kilowatt machine the armature resistance, warm, is .0295 ohm, and it is wound with two No. 15 B. & S. wires. The field resistance, including the regulating box, is 100 ohms. This gives a drop of 5.04 volts in the armature, and an efficiency of 90 per cent. at 1,100 revolutions of the armature. The floor space occupied by this machine is remarkably small, the dimensions of the machine being as follows: Length, 18¼ inches, outside of pulley; width, 19 inches, outside of rails; height, 18 inches.

The 25 K. W. machine has six poles, an armature resistance of .015 ohm, and a field magnet resistance of 30 ohms. The diameter of the armature is 39¼ inches and it runs at a speed of 390 revolutions per minute. The floor space occupied by this machine is 46½ × 46½, and 48 inches high. The 50 K. W. machine has 8 poles and the 100 K. W. 10 poles; the latter running at 200 revolutions per minute and occupying a floor space of 78x82 inches, and standing 82½ inches high, with a diameter of armature of 68 inches. Each of these machines has but a single magnet coil.

The factory of the Waddell-Entz Co. at Bridgeport, Conn., where these machines are now being constructed, is equipped with the most modern machinery, and it is safe to say that by their use, in connection with the simplicity of the design employed, the production of dynamos and motors has been brought down to a degree of simplicity and cheapness which would hardly have been believed possible but a short while ago.

ELECTRICITY AT THE PLOW.

BY

A. A. Denton

Of the U. S. Department of Agriculture.

The following statements are not, perhaps, in the regular line of The Electrical Engineer, but if they turn attention to practical problems which immediately concern the prosperity of the Great Plains of the West, they will be well worth space in its columns.

In the States which occupy the Great Plains there is an immense area, nearly level, free from stones, trees, or other impediments to cultivation of the soil by power machines. The sole power now available for the cultivation of this almost boundless farm, is animal power. Western farmers wisely, perhaps, certainly necessarily, discard hand implements, so far as possible, and depend almost wholly upon animal power machines in the production of immense crops of grain. The use of animal power always has been, and always will be subject to limitations. Manufactures made comparatively little improvement until the adoption of efficient prime motors. Disconnect engines and motors and turn the shafting of a manufactory by flexion of muscle, and see how essential to modern manufactures are modern motors. So long as commerce was dependent upon galley slaves or upon slow-moving caravans, so long it was necessarily limited. Agriculture is now where Manufactures and Commerce were before the adoption of efficient motors, and like them it will make wonderful progress when it substitutes tireless motors for animal power.

As a consequence of this limitation of power in agriculture, a very large part of the Great West lies fallow and unproductive. The annual prairie fires harvest the natural crop of grass. The useless smoke of these prairie fires should take the form of food supply for the hungry millions of the earth. They should be replaced by wheat fields of vast extent. The rapid extension of agriculture in the Great West is simply a matter of the application of efficient motors equal to the demand of agricultural work in that section.

There has been very great improvement in agricultural work in the last half century, and all of that improvement is due to the substitution of animal power, or of steam power, for manual labor. The application of animal power to the reaper performs the labor of 30 men. The application of power to the threshing machine saves two-thirds of the manual labor formerly required. The application of steam power in the locomotive renders the carriage of farm products easy. It is in consequence of these comparatively recent applications of power that the Western States have developed production to a degree which would have been impossible in previous centuries. And it is in this line, the adoption of efficient motors, that agriculture will make still more wonderful progress. Only a beginning has yet been made in the application of power to agricultural work. Agriculture is inferior to manufacture, as its prime motor, animal power, is inferior to steam power. Western agriculture requires to take a step in advance, by substituting a more powerful motor for animal power. In agriculture proper, that is, in the growing of crops, invention has accomplished but little, and that is simply in the line of substituting animal power for manual labor. At the dawn of civilization, the barbarian farmer, with his rude plow drawn by bullocks, was not so greatly inferior in accomplishment to the Western farmer with his steel plow drawn by his overworked team. In the saving of crops, after they are produced, invention has done much. We harvest 20 acres of grain per day, we thresh 20 acres per day, we carry the grain 500 miles per day to market, but by the inefficiency of its motive power the plow is limited to two acres per day. Our reapers can reap more grain, our threshers can thresh more grain, our locomotives can pull longer trains, loaded with grain, but Western agriculture is held back by the inability of animal motors to plow faster and deeper and more cheaply. It is thwarted, in a measure, by plowing done out of season, done badly, and expensively. It is limited by the amount of work which can be got out of its tired motors.

There is cruelty to animals in our Western system of agriculture. With immense work and with feeble motors the result is the destruction of the motor. With limitless power in the earth, in the air, and in the sea, we drive helpless animal motors to death. Invention has placed the burden of agriculture upon them, and they are broken down when they should be in their prime.

It appears useless to exploit steam as a motor in agriculture. The steam engine has apparently been improved nearly to its limit. The difficulties in the way of applying it to agricultural work appear to be inherent and unavoidable. On foundation or on rails it is indeed a giant; when it touches earth it is powerless.

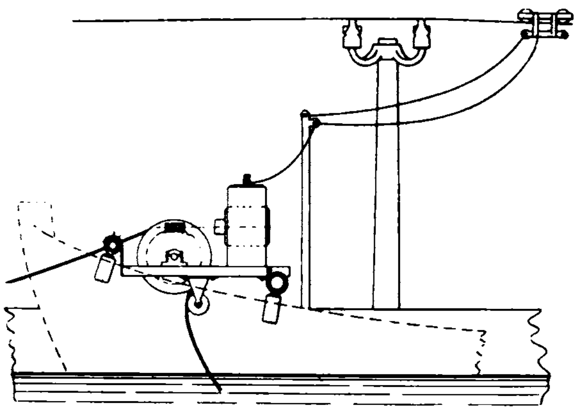
It appears otherwise with the electric motor. It is simple, its few wearing parts can be protected from dust, it has ample power, it has not excessive weight, it carries neither fuel nor water.

In its simplest expression, the problem is the dragging a plow, a harrow, a seeding machine, a reaper or a wagon loaded with grain, half a mile, in a straight line, reversing, and dragging it back again, simply passing to and fro, until the entire field is worked.

In the many applications of electrical work, this, the most important and the extensive application of all appears to have been entirely overlooked. This shall lighten human labor, shall relieve suffering animals, shall increase production, decrease cost and cheapen food. We will wonder, a few years hence, how men produced food for all mankind by use of the whip. And we will point to the old-fashioned plowman, urging his tired and slow-moving team, as we point to the old-fashioned man who swings the old-fashioned cradle in grain. There is urgent demand in agriculture for electrical engineering.

TOWING CANAL BOATS BY ELECTRICITY.

The fact that a vast amount of freight is still transported by means of canal boats, and that these boats are



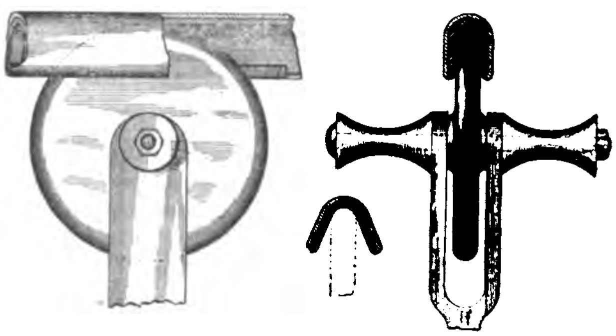
Towing Canal Boats by Electricity.

still drawn by horses or mules, as in the days of Rameses or Tiglathpileser, lends especial interest to a recent invention of a German engineer, Mr. Otto Büsser which is well illustrated in the accompanying drawing. As will be seen, a stationary cable is laid at the bottom of the canal and is grasped by a set of sheaves on the deck of the boat, actuated by an electric motor. The current is supplied to the latter by means of trolley wires strung along the bank, the trolley making contact on the upper side of the wires and being towed along by the flexible conductors.

A peculiar feature of this arrangement is that the whole installation is portable, and is readily fixed to the gunwales of the boat as it enters the canal, and removed at the further end. This is accomplished by fastening the motor upon a bed-plate resting upon adjustable cross-rods at whose ends are pivoted vertically clamps which fit over the gunwales and are firmly held by set-screws.

THE SARGENT INSULATED TROLLEY WIRE.

In order to obviate the necessity of guard wires in overhead electric railway construction, and to remove, at the



Figs. 1 and 2.—Sargent's Insulated Trolley Wire.

the same time, a serious source of trouble in the management of such roads, Mr. Charles E. Sargent, of Chicago, has devised the novel form of trolley wire shown in the accompanying illustrations.

As will be seen, the conductor is ∩-shaped in section, and has its upper and outer side covered with insulation, the trolley wheel being without flanges, and traveling in the uninsulated groove formed by the inside of the ∩.

The two spools of insulating material seen on opposite sides of the wheel, Fig. 2, are for the purpose of striking against the lower surface of the wire and limiting the upward movement of the free end of the trolley-arm when the trolley-wheel misses the wire.

This form of wire, has of course, considerably more rigidity than the ordinary cylindrical wire in use now, but this, it is claimed, is not sufficient to prevent its being coiled readily on rollers for transportion.

THE MOORE TROLLEY AND AUTOMATIC DEVICE FOR CONDUIT RAILWAY WORK.

BY

D. McFarlan Moore

The partial success of a number of conduit electric railways in Europe has led many to believe that the solution of the electric railway problem lies in some form of

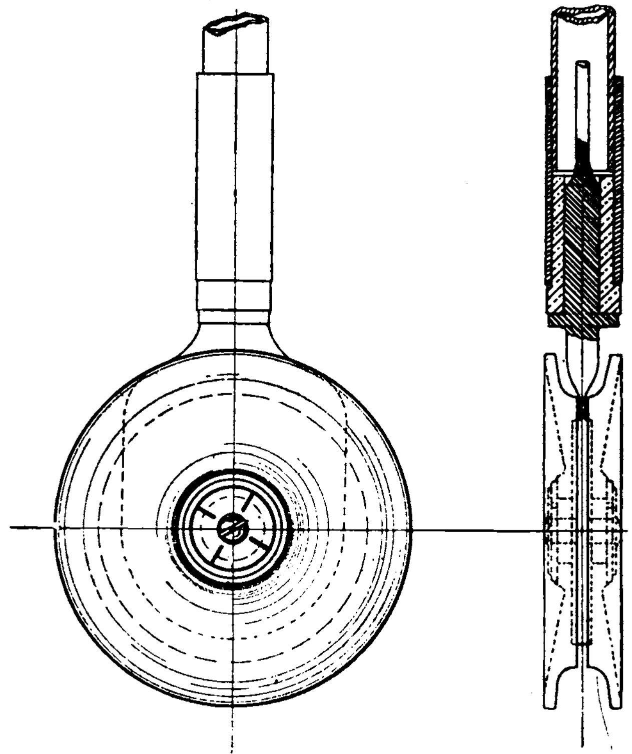


Fig. 1.—Moore's Conduit Trolley.

the conduit system, and particularly as the use of the overhead wire is absolutely prohibited in many large cities, such as New York and Chicago. It seems also to be well recognized that in the ideal conduit system of electric railways the trolley or contact device should be permanently attached to the motor truck, and not be detachable from it.

This result can be successfully accomplished by the use of the trolley illustrated in the engraving, Fig. 1. It is designed to be lifted from the conduit at any point on the line, and as such is the narrowest trolley that can possibly be constructed, being a trolley wheel without a yoke. As each half of the trolley has its own bearing, it may be termed a split trolley wheel. Each half of the wheel runs independently of the other half; this is advantageous in rounding curves, as it makes the contact more perfect. The principle involved in this trolley is by no means confined to railway work, as it can be applied in many instances for moving contacts in general, and especially when large working conductors are used. Its construction is simple and cheap, and its various parts can easily be replaced. Its design is such that the slot in the conduit need be only three-quarters of an inch, or less, in width.

The application of electric power for operating tram-cars, transfer tables, etc., in machine shops, foundries, mills and manufacturing establishments of all kinds is rapidly becoming an important part of electrical engineering railway work. In every case it is desirable, and in many cases absolutely necessary, that the trolley wire or working conductor should be beneath the ground or floor of the shop. This is necessitated in many instances by the use of traveling cranes, which preclude the possibility of employing an overhead trolley wire. In many large manufacturing establishments it is desirable also to have the tramway run not only inside of the various buildings, but also from building to building, and if the buildings are widely separated it may be required to connect them with the overhead system.

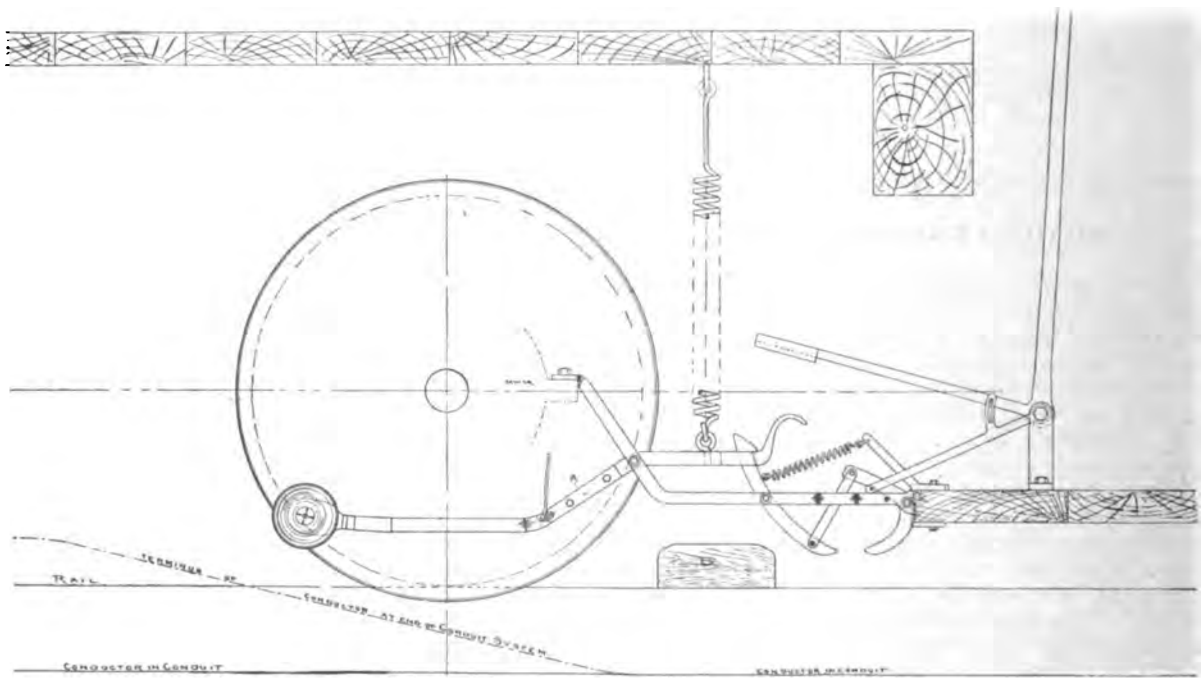


FIG. 2.—THE MOORE AUTOMATIC DEVICE FOR RAILWAY CONDUITS.

Fig. 2 shows an automatic arrangement for raising and lowering the trolley when necessary to change from the underground to the overhead system, and vice versa. As will be readily seen the levers are operated automatically by means of the block, B, placed in the centre of the track. The trolley is raised from the conduit by simply placing the conduit conductor on an incline, the inclined portion of course being "dead." The cheapest and best forms of conductors for conduit work when using this trolley are iron or copper bars or angle iron. The lever, C, is provided only as a positive arrangement in case the automatic device should not act, owing to the removal of a block or for some other like reason. In case a return conductor is required the main trolley lever can be forked at the point marked A, so that two trolleys can run in two conduit slots separated by about six inches.

L'Industrie Electrique, a new Parsian electrical journal, will be published from the beginning the year under the able editorship of M. E. Hospitalier.

HOW TO INVENT THE SUCCESSFUL COMPETING TELEPHONE.

BY

Edward P. Thompson

A POINT of valuable knowledge, among other matters, with which the would-be inventor of the successful competing telephone should be equipped, is the gist of each class of telephone, which has been invented thus far. It is almost safe to say that the successful competing transmitter will consist of some slight improvement over some existing improvement or original invention. The most powerful example, which presents itself, is the very transmitter which suggests the present problem. Although the result is far inferior, the Reis transmitter of musical sounds is exactly like the Berliner transmitter, except to those who know the gist of both. In each case two terminals of an electric circuit are normally in contact. However, when the device is in operation, the contacts separate in the one, and remain together in the other with variable pressure. It is found that all the telephones at present known are divisible into a comparatively few classes, and that a short sentence will give the pith of each. They are treated, not in any chronological order, but in the order in which they naturally appear in the mind. Even if read, not for the purpose of assisting in inventing, the classified knowledge may be useful in other ways.

The State of the Art.—In one or more transmitters at present known, electrical undulations, corresponding to air vibrations, are produced by causing the mechanical energy of the condensations and rarefactions of the air.

To vibrate a diaphragm of iron before the poles of a magnet.

To vibrate the diaphragm of iron before the poles of a magnet in which the core is partly or wholly of steel.

To vibrate a steel diaphragm before the poles of a magnet with or without a core.

To vibrate a magnet before the poles of a second magnet.

To vibrate an iron sheet *between* the poles of a magnet.

To vary the temperature of a heated conductor of very small diameter, such as a platinum wire, the condensations and rarefactions of the air causing the alternate heating and cooling of the conductor (comparatively) whereby its resistance is similarly varied.

To vary the temperature upon the face of a thermopile, the condensations and rarefactions of the air causing an alternate heating and cooling of the thermopile, whereby electrical undulations are produced (theoretical).

To vary the length of a continual spark between the two electrodes, the electromotive force of the current being sufficient to maintain the spark (theoretical).

To vary the linear resistance of a ligature, such as a carbon filament, the air vibrations causing a conducting liquid to rise and fall alternately along a part of the length of the wire.

Same as above, the air vibrations causing a second conductor to intermittently touch or short circuit variable portions of the first conductor.

To vary the amount of light falling upon a conductor, such as selenium, which is sensitive to light in such a manner, that for variable light, its resistance varies.

Same, except that a substance sensitive to heat rays is employed.

To vibrate a card board, supporting iron filings, before the poles of a magnet.

To circularly vibrate the armature of a minute dynamo, before the poles of the field magnet.

To vary the pressure existing between the two carbon or metallic or conducting liquid electrodes normally and abnormally in contact with each other.

Same, the number of the electrodes of one or both polarities, being increased.

Same, one of the electrodes, when metallic or carbon, being pulverized.

Same, in which one of the electrodes is a valve, loosely located upon the end of a tube which is the other electrode.

To vary the pressure upon the plates of a voltaic pile, an alternate increase and decrease of distance between the plates causing variable amounts of current generated.

To vary the shape of a globule of mercury balanced in a conducting liquid, the vibrations of the better conductor, mercury, varying the resistance of the circuit.

To vary the static charge of condenser plates, whereby the electric current of the line becomes varied as to its electromotive force.

Conditions of the Problem.—It is needless to mention that these are very severe. The transmitter must possess novelty over all those at present known, and further, it must be equal and if possible, superior, to the carbon transmitter. It should be applicable to long lines, and in such a manner that the receiver will give forth the words clearly and loud enough to be heard intelligently. It should serve the test of transmitting the ticks of a watch and whispering, when two or three feet away from itself not simply over a small distance, but for a mile or so. For a short distances it should transmit the sound of heavy breathing. It is assumed that a good Bell receiver is used, such as that on which the patent expires in March, 1893. One of the difficulties, in order to be as profitable, commercially as the carbon transmitter, is the cost of construction. The latter consists substantially of two pieces of compressed carbon powder, a diaphragm of tin-type metal, and the frame, the carbons being supported in a relatively yielding position, and means of adjustment being provided. It is one of the cheapest electrical devices manufacturable.

ELECTRIC LOCOMOTIVES IN FRANCE.

The French Northern Company will shortly make some trials with an electric locomotive between Paris and St. Denis, and afterwards, if these prove satisfactory, between Paris and Calais. On falling gradients the *vis viva* of the train will be utilized for recharging the accumulators.

IS IT NECESSARY TO BOND ELECTRIC RAILWAY TRACKS?

In an article on the Gibbon duplex rail that was published in The Electrical Engineer of Oct. 29, 1890, the suggestion was made editorially that with such a continuous rail it should no longer be necessary to "bond" electric railway tracks. Rail bonds are at present a necessary evil, and while many improvements have been made in them, very few electric railway managers would care to go on using them if they could be dispensed with. Not only do they often introduce seriously wasteful resistance, but very frequently they disappear altogether, leaving merely a stain in the earth to signify that they once were there, very much as Dickens represented one of his characters to have vanished, leaving only a grease spot behind. It therefore occurred to us that the Gibbon rail, altogether aside from its qualities as a rail, might offer an effective remedy for the "bonding" trouble. Learning recently that a section of this track had been furnished to the Brooklyn street railway companies, we obtained permission for a test of it by Mr. Townsend Wolcott, who has now submitted the following report to us under date of December 24:

I have examined, according to your request, the section of track furnished to the Atlantic Avenue Railway Co., Atlantic and Third Avenues, Brooklyn, by the Duplex Street Railway Track Company.

The track is so keyed together for the purpose of securing mechanical continuity and strength, that electrical continuity is at the same time secured, thus rendering the track a good electrical return for trolley or conduit roads, without any other bonding than that which is a part of the system and which does not involve extra expense as do the ordinary methods of bonding.

I made a bridge test of the above-mentioned section and found the resistance too small to give an indication on the bridge, although the latter showed .001 ohm very plainly. The test current had to pass through two keys and around one complete joint.

I think this track when properly laid, will be found practically equal to a continuous rail both mechanically and electrically.

Townsend Wolcott.

This seems to confirm our opinion very thoroughly, and we print his report as one of interest to our readers in the railway field. We have now suggested to Mr. Wolcott the desirability of a direct comparison, electrically, between this track and that of some electric road with "bonded" tracks lately finished. Such a comparison has now been undertaken, and we hope soon to give the results. In the meantime, we shall be glad to hear from any of our readers on this important subject.

INFLUENCE OF STEAM ON PERMANENT MAGNETS.

The influence of steam on magnets is the subject of an interesting note in the *Schweizerische Bauzeitung* in which reference is made to the researches of Strouhal and Barus. These have shown that with long-continued heating in steam, magnets lose from 28 to 67 per cent. of their power. If, after this, the magnets are remagnetized and again exposed to the action of steam, only a very slight loss of magnetic power is found to take place. The experiments which have been made would seem to warrant the conclusion also that after such treatment a magnet is less liable to deterioration from mechanical vibration as well as heat. In one of the experiments, a short magnet was boiled in water for four hours. It was then magnetized and held in an atmosphere of steam for two hours more, after which its magnetic moment was measured. It was then subjected to 50 blows from a piece of wood, both transversely and longitudinally. Again measuring its magnetic moment, showed a loss of $\frac{1}{600}$, and on repeating the hammering with the wooden bar the loss was $\frac{1}{400}$ of the original moment. In view of all this, repeated steaming and magnetizing is recommended as a good means of securing permanent magnetism in pieces of hard steel.

ELECTRIC ICE-HARVESTING MACHINERY.

BY

F. E. Kinsman.

In 1805 Mr. Frederick Tudor, of Boston, began the exportation of ice. In 1832 the entire quantity exported was less than 5,000 tons, all of which was taken from a pond in Cambridge, Mass. In 1846 there were 65,000 tons exported; in 1856 it reached 146,000 tons, while in 1875 the shipment of ice to southern cities and ports exceeded 1,000,000 tons. To-day we are shipping large quantities to European ports in addition to an extensive Southern trade; even in view of the fact that Norway is supplying large quantities, we are able to sell ice in Great Britain, in competition with nearby countries, and this notwithstanding the fact that our method of cutting and harvesting has not been materially altered since Mr. Tudor's first effort in 1805. Many efforts had been made to improve the process of cutting and handling ice, but with the exception of the improved form of the old-fashioned ice-plow, drawn by horses. which requires two men each, one to lead the horse, and the other to guide the plow—and the method of hoisting the ice into the storage building by steam power, practically nothing had been accomplished, until the year 1890, when the writer brought out his self propelling electrical ice-cutting machine, which can be made to do the work of any number of horses, and the necessary detail of laborers to manage them.

No branch of industry of any importance, has suffered such neglect, and at the same time assumed such enormous commercial importance as the ice business of the United States. Its importance to our every-day life, was clearly brought out by the great outcry that was raised by the press during the winter of 1889-1890, when it was found that there was likely to be an ice famine, and its domestic and sanitary value was even more clearly demonstrated by the comparatively high prices which the public were compelled to pay for that which was consumed, most of which was brought from the extreme northern sections of the United States. The difficulties of securing the crop from such points, and the high price consequent thereon, greatly stimulated the introduction of artificial ice-making apparatus. This was done to such an extent that, naturally, ice men began to realize the important character of their new competitor and to look about them for means of reducing the cost of harvesting and handling their product. They found that the principal points to be considered were, first, the matter of reducing first cost; second, the securing of locations where an unfailing supply could be had near the market. The first item, that of first cost is largely made up of the price paid for labor and teams. Owing to the knowledge on the part of the workmen of the fact that frequently but few days were vouchsafed the companies in which to secure their crop, they could practically place their own figures upon their services and for the use of their teams, where such were required.

Another item of grave importance, in the aggregate, was the loss of horses by drowning (one company is reported to have lost 27 in the winter of 1891 from this cause); another source of loss is from influenza contracted by exposure on the ice fields. The drawing of an ice plow being an absolutely dead weight, requires a constant drag, and those acquainted with the business well know how quickly a horse begins to perspire, even in the coldest weather. It only requires a stop of a few minutes for rest, or any other cause, to give them a severe chill and cold, which is likely to develop into lung fever or pulmonary diseases, which is said to be one of the largest indirect items of cost in the harvesting of natural ice.

Another important item, is the trimming of irregularly shaped cakes of ice, when they reach the foot of the hoisting apparatus. This irregularity is due to the fact that the plow now in use cuts but from three to four inches the first trip, and from two to three inches the second trip, and approximately two inches the third trip, a total of from six to nine inches, leaving, with 18 inch ice, from one-half to two-thirds to be split, and any irregularity in splitting has to be corrected before it is passed into the storage house. It has also been found that the old method of packing ice with layers of straw or sawdust between each tier, was troublesome and expensive. They therefore adopted the method of corrugating the cakes of ice, as they passed into the ice-house by a special attachment connected with the hoisting apparatus. This permitted the putting of the corrugated faces together, which answered the same purpose as straw or sawdust, namely, prevented the cakes from freezing together in a solid mass. This corrugating and trimming of the cakes of ice left around large houses a troublesome accumulation of refuse ice, the removal of which was not an insignificant item of cost. These matters are however to a certain extent governed by circumstances within the control of the companies themselves.

The second point, however, that of an unfailing supply, is one over which the companies have had no control in the past, and one in which the writer proposes to come to their assistance, by the use of apparatus with which they will in a measure be able to overcome the unfavorable condition of the season, and to harvest ice that is thinner than it is possible to harvest with horses.

It is well known that the temperature of the water under the ice is higher by from six to eight degrees than the ice. As it is impractical to remove the snows which fall upon the ice before it is thick enough to bear a horse, the thickness of the ice is somewhat reduced by having a comparatively warm body of water beneath it and a protecting blanket of snow upon it, which would not be the case if the snow could be economically removed as fast as it falls, thus exposing it to the lowest possible temperature.

This can be accomplished by the electrical self-propelling snow-removing apparatus, devised by the writer, with but comparatively little trouble and expense. The planing and cleaning machine is equipped with a scooping chamber, which can be dumped when once filled or upon approaching the shore limit of the ice field, while the planers can be raised or lowered sufficiently to remove the unevenness of the upper surface caused by rough and windy weather, when the ice first begins to make. These planers are detatchable at will; they are furnished either rotary on a plane with the ice, or revolving before the saws. The cutter or groover is so constructed as to admit of the easy adjustment of the knives for cutting between the thickness of ice, where, if it is desired, the shafts upon which the knives are mounted in gangs are also supplied with corrugators which corrugate the upper surface of the ice as it is cut. This corrugating upon the field is a decided improvement over doing the work at the ice-house, as all the refuse ice made or produced by cutting and corrugating is floated off on the water when the cakes are split from the main body, and become submerged in the water. Here it is well to mention the fact that, on account of the greater depth to which the main grooves are cut which divide the cakes, a much more even side is obtained, as the shorter the splitting space, the less divergence from a true line.

The electric ice-cutting machine designed by the writer is shown in side and end elevation respectively, in the accompanying engravings, Figs. 1 and 2. The illustrations are so clear as hardly to require a detailed explanaiion. The cutters are driven direct by the armature which has an elongated shaft upon which the cutters are mounted, thus obviating the necessity of using belting or gearing. The depth of the groove to be cut can be regulated by a hand-wheel under the control of the attendant, the cutters being raised by a worm-and-tooth segment. The same shaft that carries the cutters is provide with two worms which, acting through shafts and bevel gears, propel the wheels upon which the machine is mounted. By this means an exact ratio is obtained between the travel of the machine and the speed of the cutters. The direction of the machine is controlled by the hand-wheel and sprocket chain passing around the pivot of the rear wheel; but the machine may also be guided by a special "guide" running in the groove last cut.

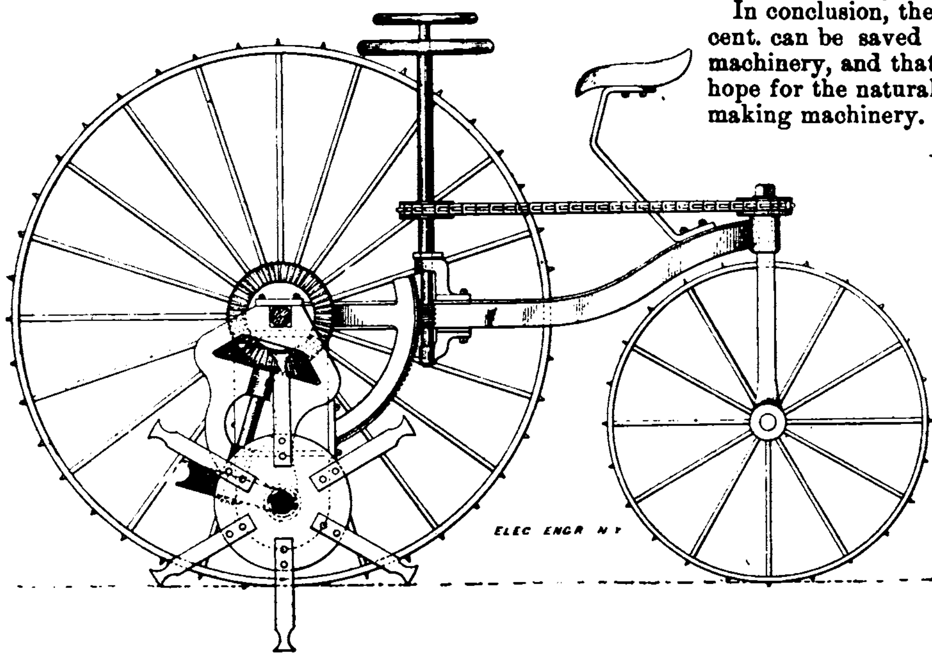


FIG. 1.—KINSMAN ELECTRIC ICE HARVESTER.

With this cutter it is possible to groove ordinary ice almost through to the water, as the machine produces no shock or jar upon the ice, and its width and length is sufficient to give it the advantage of a broad bearing surface, while the weight of a No. 2 machine does not exceed that of a fair-sized horse; a No. 4 machine, carrying a gang of four cutters is somewhat heavier but not enough as to prevent cutting very thin ice with it.

The great change secured by the use of electricity in ice cutting is that the apparatus weighs comparatively little, and that the current can be generated at a merely nominal cost by the same power that lifts the ice into the house; while the same engineer who now attends to the lifting apparatus also cares for the generator. It will therefore be seen that the entire cost of grooving ice on the field is reduced to the wages of a man who rides the machine and a few extra pounds of coal used in the furnace, and that the entire force can be concentrated upon the housing of the ice, thus admitting of a full crop, which would otherwise be prevented by a sudden change of weather. As stated, the total weight of a No. 2 machine, with a capacity equal to from fifteen to twenty horses does not exceed that of a fair-sized horse, but, unlike the horse, requires absolutely no attention when not in use. It does not take cold when standing still, nor is it a total loss if it accidentally goes overboard.

As to the method of transmitting the current to the motor on the machine, two methods are available. Use can be made either of a trolley wire supported on sliding stands, or the cutter can be supplied with a reel. In either case no difficulty would be experienced.

In conclusion, the writer believes that from 30 to 50 per cent. can be saved by the use of electric ice-harvesting machinery, and that this method stands to-day as the only hope for the natural ice men against improved modern ice-making machinery.

LENGTH OF ELECTRIC WAVES.

M. POINCARÉ has announced to the French Académie des Sciences that M. Blondlot has measured by a new method the length of waves of electric oscillations, and that he has found that this length is proportional to the square root of the capacity, and to that of the self-induction, as required by Sir Wm. Thomson's formula. The mean of his experiments has given for the speed of propagation of electric waves in a metallic wire a figure not greatly different from the speed of light—a difference less than can be accounted for by errors of observation. The result is confirmatory of Maxwell's theory that light is due to alternate currents of very short periodicity.

AN ELECTRIC ROAD AT NIAGARA FALLS.

A CORPS of engineers on the Canadian side are now mapping out the line of an electric road between Chippewa and Queenston. The route through Victoria Park will be located just under the bank, along the western boundary of the reservation. It is likely that the power for this road may be obtained from the Niagara River, and a much bigger scheme is on foot for a power canal cutting across from the river and emptying down the Queenston Heights below the whirlpool.

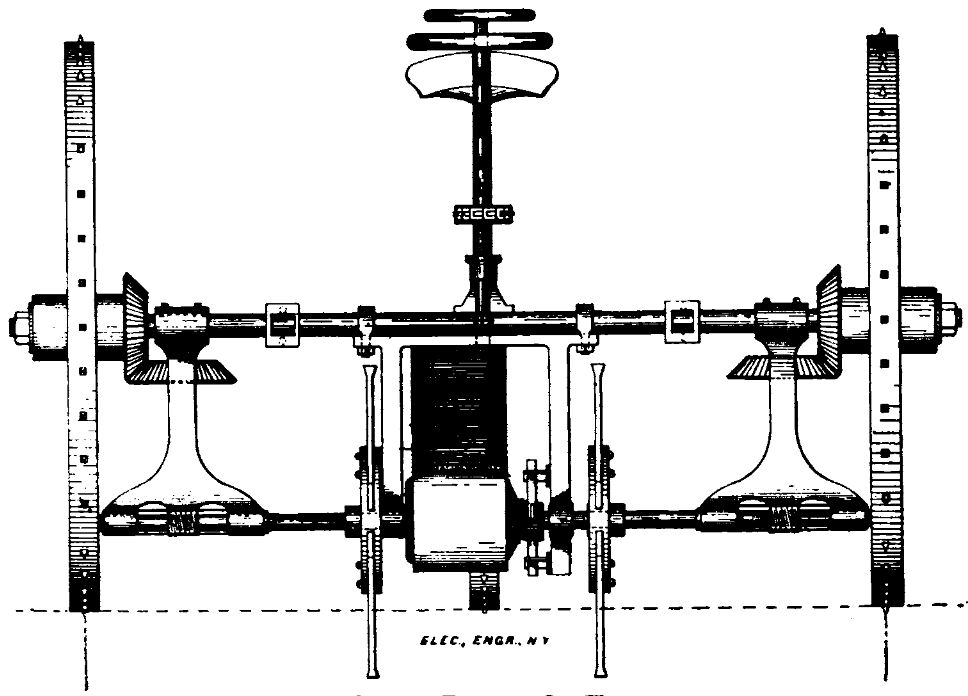


FIG. 2.—KINSMAN ELECTRIC ICE HARVESTER.

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VOL. XII. NEW YORK, DECEMBER 30, 1891. No. 191

As we do not pound on a piano with all our strength to get a sound, but select different keys, so by using those components of light which we require, we may avoid wasting the other parts of the spectrum.—Prof. J. B. de Motte.

AGRICULTURAL ELECTRICAL ENGINEERING.

WE have from time to time printed notes on experiments which had been made looking to the influence of electricity on the growth of plants. These experiments may be divided into two classes; first, those involving the influence of the electric light directly upon vegetation; and, secondly, those in which the current was made to act directly upon the seed of the plant until its maturity. The experiments of Siemens some years ago and the more recent ones carried on in the Agricultural Department of Cornell University ought to show in some degree what can be expected by the first method, while the recent investigations by Specnew, in Russia, and others, give a fair indication of the value of the second method But electricity is capable of still further applications in agriculture in a direction which promises immediate results, and which cannot fail to secure for it the attention of agriculturists. The field still open to the electrical engineer is pointed out very forcibly by Mr. A. A. Denton, assistant in charge of the U. S. Department of Agriculture at Sterling, Kan., and consists in nothing less than the application of electric power to plowing. Mr. Denton points out that while we apply steam to the harvesting, threshing and transportation of grain, we are practically still pursuing the methods of thousands of years ago in the manipulation of the earth preparatory to the reception of the seed. As he puts it, while we can harvest and thresh 20 acres of grain per day, we can, by the method at present in vogue, in which animal power alone is employed, only plow up two acres a day. The problem to be solved, then, consists merely in providing a motor which shall be able to drag whatever appliance is necessary either for the tillage of the soil and the harvesting of the crop, in a straight line half a mile, reversing and dragging it back again until the entire field is worked. Mr. Denton considers the steam engine as unsuitable for this purpose and sees in the electric motor the ideal machine for this purpose. While the suggestion of the application of electric motors to the tilling of the soil was actually put in practice some 10 years ago in France, at Sermaize, it seems to have gone no further than the experimental stage. Mr. Denton's suggestion is, therefore, an eminently timely one and appears to involve no serious difficulties in its application. Nearly all the Western States have coal measures from which fuel can be drawn, so that the substitution of electric for animal power can be carried out with a large saving in time and cost. Many readers of THE ELECTRICAL ENGINEER will remember, too, that Mr. W. Forman Collins, of the staff of this paper, had an excellent article some months ago on the relation of electricity to the irrigation of the Western plains.

THE ARGUMENTS ON THE "HYDROCARBON" PATENTS.

THE argument of Mr. Christy, in behalf of the complainant in the recent trial of the suit of the United States Electric Lighting Co. against the Edison Lamp Co., involving the question of the validity of Weston's patent for the hydrocarbon treatment of incandescent lamp filaments, of which we give a full synopsis in another column, brings to a close the proceedings in this interesting and important case. In pursuance of a policy which has been consistently adhered to by the conductors of THE ELECTRICAL ENGINEER, that of placing upon record in its columns every matter of permanent interest affecting the leading electrical industries, no trouble or expense has been spared to present a full and adequate report of the arguments of counsel in each of the three great legal controversies, the final results of which must practically determine the ownership or control for some years to come, of the incandescent lamp manufacture of the United States. The first of these legal contests was the McKeesport case, so called, involving the Sawyer-Man patent for a fibrous carbon, and decided by Justice Bradley adversely to the patent; the second was the New York case, involving the Edison patent for the carbon filament, in which the patent was sustained by Justice Wallace; and the third is the New Jersey case recently tried in Philadelphia and now awaiting the decision of Justice Acheson, on Weston's hydrocarbon patent. Not only has no other journal attempted to give a report of the proceedings in these cases, but it may not be out of place to add that THE ELECTRICAL ENGINEER has received the highest commendation from eminent counsel engaged on both sides for the completeness, accuracy and impartiality of its reports of these trials. It is to the summary of the testimony of witnesses as given in the arguments of counsel, and to the opinions of the learned jurists with whom the ultimate decision of these controversies rests, that the future historian of the art of electric lighting must look for the greater part of his material, and this consideration must be our apology, if any be needed, for having devoted so large a space to matters which may seem to some of our readers of scarcely sufficient immediate interest to justify it.

ELECTRIC TRACTION FOR BROOKLYN.

A LONG fight at last is drawing to its close, and the great city of Brooklyn falls in line with the others that have already adopted electric traction. The common council has given permission to the Brooklyn City, Coney Island and Brooklyn, Brooklyn City and Newtown, and the Atlantic Avenue lines to change their motive power from horses to the overhead trolley system, and it is understood that Mayor Chapin will promptly approve the ordinance; while there is not the slightest reason to expect that the State Railroad Commissioners will change from their favorable attitude toward electric traction. This action by the Brooklyn city council means that about $12,000,000 will be spent there in the next two years in making the change, the Brooklyn City road spending alone at least half that amount.

The opposition to the change has been wild and absurd as usual, with the familiar stories of plague, nuisance and sudden death, and without a single fact in support of the allegations. The *Brooklyn Eagle* in an admirable editorial on the subject congratulates the citizens on the coming addition to the means of rapid transit, and points out that in like manner, though more vigorously, other boons were fought against in the City of Churches, such as the introduction of the water supply, the horse railroads, paid firemen, elevated roads, and uniformed police. All these things though bitterly opposed have come, and now everybody rejoices in their existence. So it will be with the trolley system. We are heartily glad to see that the street railway companies have made so successful a fight for themselves and for the public they serve.

ICE HARVESTING BY ELECTRICITY.

ON the preceding page we have referred to the adoption of the electric motor in agricultural operations, and the benefits which, it is shown, could be derived thereby. The arguments followed in that case are quite applicable to another case which, also, has thus far not received the attention that its importance would seem to merit. The methods pursued in ice harvesting have undergone no change in years, the horse being still the motive power employed. The manner in which the electric motor can be applied for the purpose and the saving in the cost of harvesting ice which can be effected by its use, furnish the subject of an interesting essay by Mr. F. E. Kinsman in this issue. As he points out, it permits not only of greater economy in the harvesting of thick ice, but it even permits of harvesting ice of such a thickness that it could not be attempted with horses; and thus admits of the profitable utilization of thin ice, which is now allowed to go to waste, although in mild winters it forms the only source of natural ice supply. It is not difficult to conceive, also, that a profitable business might be developed in the operation of portable ice-harvesting plants, so that the itinerant grain-threshing machine will find its counterpart in the traveling ice-harvesting machine.

THE SUCCESSFUL COMPETING TELEPHONE.

FOR several years subsequent to the invention of the Bell telephone and its successful application, a large percentage of the applications for patents filed in the Patent Office, in the Electrical Department, consisted of telephonic devices of one form or another, not a few of these relating to new forms of transmitters. Now that the transmitter in present use appears to be endowed with prolonged life by the recent issuance of the Berliner patent, we shall probably note a large increase in the number of telephonic inventions submitted to the Patent Office. Every intelligent inventor ought to know the state of the art in which he is seeking to effect improvement, and for those who have not followed the telephonic art with a view to its improvement, a résumé of the various methods of obtaining telephonic effects in an electric circuit will at this time prove of value. The admirable résumé of Mr. E. P. Thompson, on another page, shows that not a little ingenuity has been already expended in this direction. The experience of the past would seem to indicate that the demand for any invention has always been met when sufficient inducement has been offered to inventors, and in this case certainly the inducement is as great as that ever offered to an inventor. Mr. Thompson suggests a great many ways in which the goal may be reached.

"AMERICA'S GREATEST RAILROAD."

THE series of disastrous collisions which has accompanied the efforts of the management of "America's Greatest Railroad" to operate "the fastest and most perfect through train service in the world," provokes the very natural inquiry why it is, that on what is alleged to be "the only four-track railroad in the world," the passenger tracks should be incessantly blockaded by broken-down freight trains, and why in such case resort must necessarily be had to the archaic and futile expedient of sending a man back with a flag or lantern, who may go or may not, as may happen, and who may be seen or may not, as may happen, by the engineer of the approaching "flyer." The truth is, that two of the tracks of the "only" being one side of the North river and the other two the other side, it is somewhat difficult to separate effectually passenger and freight traffic; while the management seem to be as yet in a state of the most deplorable ignorance in respect to the utility, for signaling purposes, of an agent popularly known as electricity. We would by all means advise these ambitious people to take a course of elementary lessons in the modern art of conducting transportation, which might be done in the kindergarten department of the railway university at Altoona, or some other institution of the kind which is not hopelessly wedded to the outgrown traditions of the days of small things.

ISOLATED ELECTRIC LIGHTING BY LOW-TENSION ALTERNATING CURRENTS.

BY

It may seem curious to old-time electricians to hear any one seriously propose to revert to old and discarded methods of electric lighting and under a new name to flaunt them again before the public as something quite new and improved, yet this is precisely what is suggested in this paper. The development of the converter has totally changed the original "alternate current dynamo-electric machine" into the high-tension "alternator" of to-day which seems capable of anything—lighting, heating, welding, metal working, tempering, soldering or of twirling armatures hundreds of miles away. So, too, the development of the choking coil may lead us to revert to the original machine in all its simplicity, and to evolve, thereby, a more perfect method of isolated lighting than has ever existed before.

When the electric incandescent lamp was first invented it was said that the life it had was much increased by the use of the alternating current. I think this was conclusively proved at the time with such lamps as we had in 1880, though it does not apply so forcibly now, with the greatly improved vacuum and the hard and durable filaments such as are now made. Still the lamps *do* wear out slowly even now, the direct current attacking the ends of the horseshoe and the alternating wearing away the filament more evenly, but still surely, until it finally succumbs at the bend.

Electricians will remember, too, the alternating dynamo of 1880 of low tension and large quantity, and the installation of lamps in parallel or two or three in series. Before the days of compound winding for direct-current machines this system had its advantages in the steadiness of the electromotive force curve for all loads. All this is history now; we had no E. M. F. curves in those days. But this style of dynamo is gone. It was considered more expensive to construct than the newly discovered compound-wound, direct-current dynamo; it required too, a separate exciter and there was no advantage to compensate for the extra cost that such a machine entails. So it fell into disuse for several years until the converter was developed; then it assumed a new garb and new sphere of usefulness.

I propose to use again this style of machine connected, as of old, directly to the mains of the building to be lighted. The difficulties attending the installation of an alternating machine have been now overcome, and the dynamo of this pattern is now infinitely simple and little liable to derangement. Moreover, the commutator of the direct-current machine is generally in a neglected condition in isolated plants, and it soon wears out because the average attendant does not acquire the knack of keeping it in condition. In this new system the lamps are placed in parallel across the mains, and the Ries regulating socket is used. With this arrangement each lamp can be turned high or low just like gas, and the whole system then presents the appearance of being unique. The system is especially useful for the lighting of our large hotels which can now be fitted up from cellar to garret bedrooms, and all with absolute safety.

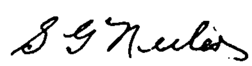
At present there is no electric light system that lends itself completely to this work. In the cities, gas is used in the bedrooms, and in the country, candles to help out the electric light plant downstairs. I have heard it stated by people ignorant of electricity that the electric light will not ascend above the first story. I am inclined to think the statement is correct of the several systems with which I am acquainted.

Extended experience with the Ries regulating socket has brought out very clearly the fact that there is great economy in systematically turning down the incandescent lamp when all its light is not required, although I am perfectly aware that theory conclusively proves the opposite to be true. There is economy in the life of the lamps themselves, and economy of power also; the lamp will last thousands of hours turned down this way, and still work out its 500 hours of good efficiency when turned on full. And then the current; the energy required to light up one corridor in a hotel would light up three or four well enough if the lamps were controllable and were adjusted to the requirements of the guests. If the light be wanted it is there; it indicates its own location and invites one to turn it on.

It is therefore contended that the low-tension alternator with the Ries regulating socket and lamps as described, introduce a combination which is an advance upon the usual practice of installing isolated plants, and that it will be found both on the score of economy and adaptability, greatly superior to any direct-current non-controllable system. It is, moreover, the only plan yet suggested for isolated lighting which is completely adapted to all the varied requirements of artificial illumination.

REACTIVE COILS IN PRACTICAL WORK.

BY



In The Electrical Engineer of Dec. 9, under the title of "Reactive Coils," Mr. Otis K. Stuart explains the principle underlying the action of the coils, by giving a very clear explanation of what takes place in a transformer, but does not take up the reactive coil as it is used commercially. In reading over Mr. Stuart's article it struck me that it would not be amiss to go a step further and explain just how the current flowing in a circuit is controlled by the reactive coil and it is with that idea in view that I have written the following, hoping the same might be of some benefit to those not already familiar with the subject.

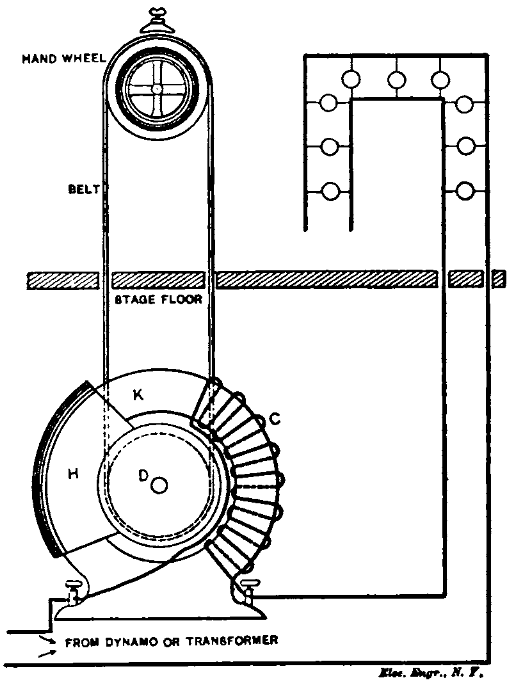
Mr. Stuart says: "A reactive coil placed directly in the circuit of an alternating system, therefore, can be made to control the amount of current going over the system. * * * Probably the most interesting application has recently been made use of by Mr. Elias E. Ries." He then gives a description of the socket, and says, "A very small reactive coil is so connected to a series of contacts that, by means of a movable arm * * * a relatively small or large amount of current may be admitted to the filament."

I think that one not familiar with the action of a reactive coil would be led to the conclusion that the only method of varying the strength of current would be by making a number of connections or "loops" into the coil and cutting out, or in, more turns which, of course, would accomplish the object, as exemplified in the Ries socket. But I think by far the most beautiful manner is that designed by Prof. Elihu Thomson and used by the Thomson-Houston Electric Company in their apparatus.

To explain clearly it will be necessary to understand that by placing a closed coil around an alternating magnetic field a current is induced in the coil forming the closed circuit, exactly similar to a transformer whose secondary is short-circuited. Now we may consider the action taking place in a Thomson-Houston reactive coil as illustrated in the accompanying diagram. This consists, primarily of a laminated iron core in the form of a closed ring K, about one part of which is wound a comparatively few turns of fine insulated wire C, covering about one-third of the circumference. Inside of this ring is a laminated iron drum D, fastened to which, and passing around the outer ring, is a copper hood H of large area, forming a closed coil about the ring and which fits closely, leaving a very small air space between it and the ring. This hood is fastened rigidly to the inner core and is provided with a handle or a pulley and belt so that it can be moved to occupy any position relatively to the winding on the ring.

When this hood is furthest away from the winding, the action is such as to increase the magnetizing effect of the coils by closing the magnetic circuit through the drum and hence to increase the number of lines flowing in the iron ring, so that the self-induction of the coil is very great and enough to nearly overcome the impressed electromotive force, thereby reducing the current flowing through the lamps.

By moving the hood so that it covers the winding, the current flowing in the hood would tend to counteract the magnetizing effect of the coils and by so doing lessen the self-induction of the same. When so placed, the relation



THE THOMSON REACTIVE COIL.

between the hood and the coils is the same as would exist in a transformer whose secondary was short-circuited and hence the coil offers but little resistance to the passage of the current. In any intermediate position of the hood the effect would be to increase, or decrease, the self-induction of the coil as the hood was moved further from, or nearer to, the winding.

The current used in the lamps is nearly in direct proportion to the brilliancy of the light; such being the case it is seen that in these reactive coils there is comparatively little loss of energy. The arrangement is such that when the hood completely envelops the winding, the coil is short-circuited, the hood completing the circuit across the terminals, and by so doing avoiding the loss due to the resistance of the coil and allowing the lamps to take their full amount of current. In the Ries socket the object is accomplished by cutting out sections of the winding and thereby reducing the self-induction in the wire and allowing a correspondingly greater current to flow.

The above, together with Mr. Stuart's article, will, I think, help to make the action of the reactive coil clear to those not already acquainted with the same. The illustration shows the arrangement employed for regulating the lights in theatres, the reactive coil being operated by a pulley and belt on the stage floor.

NOTE ON GALVANIZED IRON TELEGRAPH WIRE.

BY

Frederic A. C. Perrine

IN the London *Electrician* for December 28, 1888, there was printed an article giving the results of tests, and the requirements of galvanized iron telegraph wire as used by the Postal Telegraph Department of Great Britain. In this article it is stated that two qualities of wire are used, one known as "high-resistance" wire and the other as "low-resistance" wire, the first giving a resistance at 60 degrees F. of 12.7 ohms per mile for a wire of the standard gauge, 171 mils, while the low resistance wire is either of "special blend" iron, 11.3 ohms per mile, or "charcoal" iron, having a resistance under the same conditions of 11.2 ohms per mile. This low-resistance wire is used for circuits exceeding 200 miles and the high-resistance for shorter lines. A tabulation of the qualities of these three grades of wire is also given, together with a mile-ohm comparison with pure iron.

According to this, the breaking strength of the "blend" iron is 3.2 times the weight per mile, of the "charcoal" 2.87 times the weight per mile, and the "high-resistance" 3.5 times the weight per mile; the two "low-resistance" wires give from 16 to 17 per cent. elongation in breaking, and the "high-resistance" 17 to 18 per cent. For a wire from 209 mils in diameter to one of 121 mils in diameter the number of twists in six inches varies in the "blend" iron from 17 to 30, and in the "high-resistance" from 22 to 38. The weight per mile-ohm of pure iron is given as 4,368.94 lbs., of the "blend" iron as 4,520, of the "charcoal as 4,480, and of the "high-resistance" as 5,080.

These are very interesting results, and in some respects remarkable, but the writer has not stated whether they are maximum or minimum figures, or whether they are averages of actual tests; neither does he seem to take into account the alteration in the mile-ohm of pure iron due to galvanizing it, since he says: "The relative resistances of pure copper and Swedish charcoal iron, similar to that used for the best line wire, are as 1 : 6.034; or the resistance of commercial iron is 6.034 times that of pure copper, not 6.558 times, as is usually given in text books. From this it appears that iron wire may now be obtained having a conductivity of 98.44 per cent. of pure iron."

Still, when he gives the mile-ohm weight of the best galvanized "blend" wire it has only the conductivity of 97.51 per cent. of that of pure iron, whereas the effect of galvanizing should be to reduce rather than to increase the weight of the mile-ohm.

In this country there is but one quality of wire at present in use for telegraph service in commercial lines, where a consistent series of tests is maintained. For short local lines and railroad private wires a great deal of steel and puddled iron is employed, but in these cases the only requirement is that it should stay on the poles and conduct. But our great telegraph companies employ for their commercial lines only the quality of iron which is known to the trade as "*Ex. B. B.*," a rather generic term, which is so interpreted by the specifications of the telegraph companies as to exclude all except the best grades of Swedish and Norway irons, which are imported in rolled rods and drawn, annealed and galvanized in this country.

Of this *Ex. B. B.* galvanized iron wire, about two years ago I had averages cast up from a long series of tests made on wire manufactured for the Western Union Telegraph Company, and found that the results varied with the size of the wire to a considerable extent; but that for any one size, the various tests were fairly concordant, and show that one wire is about 4 per cent. poorer in conductivity than the figures given on the English "blend" low-resistance wire, while the figures given on the "high-resistance" wire would not fill the specifications of our telegraph companies.

The exact averages on our wire are:

Date of test.	Size, B. W. G.	Quantity tested.	Resistance per mile.	Weight per mile.	Weight per mile-ohm.	Breaking weight.	Twists in 6 inches.	Elongation, per cent.
Feb., '88, to Jan., '89..	4	85 miles	6.51	716.7	4,664	2,016	18.5	13.83
Jan., '88, to Dec., '88..	6	650 "	8.55	544.96	4,663.5	1,454	18.9	13.82
Sept., '88. to Jan., '89..	8	3,500 "	12.18	379.8	4,629.5	980.5	21.4	15.16
Sept., '87, to Nov., '89..	9	8,300 "	14.008	331.9	4,620.5	877	24.3	14.21

The gradual decrease in the weight of the mile-ohm here to be observed is partially due to the greater proportionate amount of zinc on the smaller wires, though from the decreased elongation as well as the increased tensile strength of the heavier wires there seems to be an indication of more perfect annealing in the case of the smaller wire.

These tests upon a given number of miles are obtained by inspection of the wire in lots of from 50 to 100 miles, out of which are selected at random a certain number of coils,—about 10 per cent.,—from which test pieces are cut and carefully measured. These may, therefore, be taken as fair averages of the wire as it is produced for stringing on the poles in service. In experimenting with various grades of iron before finally selecting that which has been taken as the standard, remarkable results were obtained, and irons were found of much better quality, but, unfortunately, of which the price, when brought to this country, was prohibitory.

I have before me the result of a test of three samples made September 26, 1881, of which the weight per mile-ohm was 4,259.5. One of No. 12 galvanized wire manufactured by the Palmer Wire Company, tested March 31, 1884, giving a mile-ohm weight of 4,226.25, as well as quite a large number of samples giving better results than 4,350 pounds per mile-ohm. A number of tests have also been taken at various times on the same wire, both before and after galvanizing, and in every case there is a reduction in the weight of the mile-ohm by at least 5 per cent., due to the greater conductivity of the zinc.

While the results given above would indicate that in this country our telegraph companies do not use as high a grade of iron as the British Postal Department, yet I should judge from the method in which the English figures are given that our averages are fully as high as theirs, while in neither case is the highest obtainable grade of iron used.

HEYL ACCUMULATOR.

In the accumulator recently introduced by M. G. E. Heyl, the electrodes are composed of combinations of plumbic, chromic or tungstic acids with calcium, barium or strontium. To increase the coefficient of output and capacity, the inventor uses more particularly compounds of calcium and lead for the reason that these are easily oxidizable. The combination $CaPbO_4$ corresponding to 68 per cent. of peroxide of lead, contains 4.56 per cent. of active oxygen. The other alkaline earths, or of baryta, or strontium, furnish analogous compounds applicable to the purpose. Besides the advantage resulting from the chemical nature, the compound $CaPbO_4$ would offer a further valuable property in its porosity; it might replace the diaphragm employed to separate the elements of cells. The analogous compounds of chromium and tungsten can be employed in the same manner.

ELECTROMOTIVE FORCE, WITH SPECIAL REFERENCE TO THE EXTENSION OF OHM'S LAW.—II.

BY

Maurice Oudin, M. S.

The measurements of E. M. F. have in all cases been made in air. The result cannot with certainty be considered the true contact force. What is measured is not the Volta effect of zinc and copper, but zinc, air and copper, which may be something quite different. With the object of finding out what influence atmosphere had upon E. M. F., Von Zahn placed a pair of metallic plates in a vacuum. The E. M. F. of the two elements was considerably lower than that in air. The impossibility of obtaining a perfect vacuum prevents any conclusion from this test. For the E. M. F. depends not at all on the quantity of the active material present. Though only a few molecules of oxygen remained in the vessel, the effect would not be materially changed. Clerk Maxwell suggested measuring the E. M. F. of two substances by the Peltier effect. Speaking of the Volta force in the first volume of his classical work, he says: "The greater part must be sought for not at the junction of the two metals, but at one or both surfaces which separate the metals from the air or other medium which forms the third element in the circuit." Oliver Lodge, who is at the head of what we may call the modern school of electricians, agrees with Maxwell's views as far as they go. The contact-force not being sufficient, we have seen, to account for the whole E. M. F., the question naturally arises, where is the true source? Prof. Lodge locates it at the junction of the zinc and electrolyte. He regards the air as a dielectric bath of oxygen. Metals immersed in it are attacked by the oxygen molecules If they do not succeed in combining with the metal, the effort to do so, the chemical strain, as it were, produces certain physical effects. Oxygen being an electro-negative element, attacks the metals with different degrees of intensity. Hence the difference of potential. The medium, air, may be replaced by a fluid. In the case of a gas the dielectric is in a state of strain. If an electrolyte be the medium a current flows on connecting the metals.

It is well known that the entire heat developed in any battery is exactly equal to the heat that would be obtained by burning or consuming the elements of which the battery is composed, in some chemical capable of acting upon these elements. Accordingly the energy of such a battery bears a direct relation to the chemical changes taking place. It would naturally follow that such dependency should exist between the transfer of energy in the battery and the E. M. F. developed. This relation calculated from the heat of combustion of the elements composing various batteries has been found to exist in some cases. But up to the present, whether from errors in our data or the omission of some necessary constant, this dependency has not been found to be universally true.

There seems now to be no doubt about the presence of a true contact force at the junction of two metals. It is scarcely appreciable, being, under the best conditions, less than the E. M. F. of a single voltaic cell. It is dependent, apparently, upon the unequal vibration of the molecules of the dissimilar substances. There is an impingement and a constraint of molecules having different velocities. The molecules of one metal fail to accommodate themselves to the time of vibration of the opposing molecules, and a flow is set up in the direction of greatest impact.

The so-called thermo E. M. F. discovered by Seebeck is a variety of contact force, produced when the junctions of a circuit formed of different metals are brought to different temperatures.

It has been found that for the production of a contact-force, it is not essential that the circuit should consist of different metals. A lack of homogeneity in two conductors of the same metal also gives rise to an E. M. F. when one juncture is heated.

Frictional electricity, or electricity in equilibrium, is the manifestation of contact-force. The specific resistance of substances that are good generators of static electricity is well nigh infinitely great compared with that of metals. In metallic bodies the excitation is at once propagated throughout the entire mass. In non-conductors it remains at the surface of contact, which is increased by the rubbing, and there accumulates. Consequently, while in metals the true contact-force is almost inappreciable, in non-conductors the same force may become very great.

One of the earliest known electrical phenomena was the property that certain crystalline bodies possess of acquiring opposite states of electrification at opposite ends, when subject to a variation of temperature. Tourmaline displays this property in a marked degree. It retains its charge for a considerable time, and if suspended in the presence of electrified bodies, it behaves much as a needle in a magnetic field. Certain crystals also become charged with electricity when subject to a mechanical strain or deformation. Quartz crystals, from their size and purity, show strong electrification under such conditions.

Another source of E. M. F. is the action of light on selenium, that rare element generally found associated with sulphur. The cell is usually made of two metals coated with selenium. Mr. Fritts used brass and gold plates. W. Siemens found the E. M. F. set up in diffused day-light proportional to the intensity of light, while Von Uljamn, using platinum plates thin to transparency, found it proportional to the square root of the intensity of the light. As the generation of a current requires energy, the question arises, Whence does it come? It is generally conceded not to be due to thermal action. It is either a chemical change resulting from the action of light, or a direct conversion of light waves into electrical energy. There is good ground for giving the preference to the latter explanation.

An E. M. F. is set up when a thin cross-shaped metallic strip conveying a current is placed in an intense magnetic field. If the terminals of a sensitive galvanometer and of a battery be connected to opposite arms, and the strip be placed so that its plane is at right angles to the direction of the magnetic field, the presence of a current will be indicated by a slight deflection of the galvanometer needle. This is the Hall effect.

A year ago there appeared in the technical press, an article on the generation of a magneto-optical E. M. F. It is well known that a ray of polarized light traversing a magnetic field in a direction parallel to the lines of force, will have its plane of polarization twisted an amount depending on the strength of field. Conversely, if by any means a polarized beam of light can be made to oscillate it ought to generate an alternating E. M. F. Prof. Sheldon claims to have reached such a result. It was shown however, by Prof. Brackett, of Princeton, that the E. M. F. detected could not have been due to the ascribed cause. We might expect from the reversibility of most physical phenomena that some effect would be produced. However, as a scientific authority suggests, since polarized light passing through a solution of sugar has its plane rotated it would follow that if polarized light fell on one side of a glass beaker containing water and its plane be rotated, sugar might be expected to fall out at the other.

The various sources of E. M. F. that have been described above are capable of evoking a continuous current. In such circuits the galvanic constants are related according to Ohm's law. Now there is another order of phenomena, where Ohm's law fails to apply. It was found early in the history of telegraphy, that when the key of the transmitting instrument was opened and shut many times in a minute, the effect upon the receiving magnet at the other end of the line was much diminished. The current for some reason did not attain its maximum value during the make and break of the circuit. With a given number of cells and a line of known resistance, the current in practice was less than it ought to have been by Ohm's law. Evidently the element of time, which did not enter into Ohm's law, had to be considered. It was not long before it was proved that the retardation of the full value of the current and its diminution when the circuit was rapidly made and broken was due to the electromagnetic induction of the circuit on itself, or, as it is briefly called, self-induction. To understand the modification of Ohm's law through self-induction, we must study the nature of induction and how this quality of a circuit gives rise to a counter E M. F.

The phenomena of induction were discovered by Faraday in 1831. Oersted had 11 years previous observed how a current affected an adjacent compass, causing it to deflect from its position in the magnetic meridian. This proved as a fundamental fact the existence of a magnetic field surrounding a wire conveying a current. Faraday took up the line of experimental investigation at this point, and by a series of brilliant and remarkable experiments brought out all the facts of electromagnetic induction. He found that when a wire was moved in the vicinity of a magnet, or when a wire conveying a current was moved relatively to another wire, a temporary E. M. F. was set up. He found this to vary in strength with the velocity with which the wire was moved. The same result was obtained when the conductors remained stationary and the current in one was increased or diminished. Although the phenomena of induction are many and complex, they arrange themselves under the heads of electromagnetic, self and mutual induction. The E. M. F. due to electromagnetic induction constitutes Faraday's principal discovery. Its general conditions have been stated. The name is restricted to that E. M. F. induced by the movement of a conductor near a magnet, or a wire conveying a current.

Both Henry and Faraday were early and indefatigable workers in the field of induction, and it is not so very strange that they independently discovered magnetic and self-induction. Priority of discovery of self-induction is given to Henry. He observed that when the current in a long wire was interrupted, a spark of some brightness appeared at the break, showing an increase in the strength of the original current. This is the so-called extra current. Henry explained the phenomenon, and gave it its present name. It is well worth while to notice here the insight Henry had at that early day into phenomena that only recently have assumed importance. In 1832 he discovered the oscillatory character of the lightning flash and also the discharge of Leyden jars. Years later Sir Wm. Thomson proved the same mathematically.

To properly understand induction, and more particularly self-induction, we must remember that a current traversing a wire produces a commotion in the medium surrounding it. We know that if such a wire be made to pass through a surface on which are sprinkled iron filings, the filings will arrange themselves in concentric rings around the wire. The circles thus formed show the direction in which the force of the current acts. When a current is started, the lines of force spread out on all sides like the ring waves in a pool of water from a central point of disturbance. When the current is broken, the lines of force collapse and fall back upon the wire. By the general theory of induction the springing up or dying away of magnetic lines produces an instantaneous E. M. F., always in such a direction as to oppose the change in the current. Hence self-induction prevents the current from immediately arriving at its maximum value on making the circuit, and causes it to persist a while after the break. It would appear as if a current of electricity possessed a quantity of the nature of inertia. A fly-wheel absorbs energy in passing from a condition of rest to a definite velocity, and then gives it all up again as work in some form on slowing down. To maintain its velocity uniform, if we neglect friction, no work need be done upon it. The analogy can be applied to the case of a wire carrying a current. Starting a current implies work done in the medium which is derived from the electrical energy of the current. Stopping the current restores the energy to the system. No expenditure of work is required to maintain its magnetic field when the current has assumed a steady regime. Faraday called that condition of the medium produced by a current the electro-tonic state. He lacked sufficient mathematical training to deduce the ultimate consequences of his experiments; but he recognized that induction depends on a change in the medium, and that in this operation work is involved.

Mutual induction is the third division of the general phenomena of induction. As self-induction is the flux of magnetic force produced around a circuit by any change in itself, so mutual induction is the magnetic flow set up in a circuit by any change in the current of an adjacent circuit. It is then the number of lines of force linked in two circuits when one circuit contains a varying current.

The current resulting from inductive E. M. F., or influenced by it, such as at the make or break of a circuit, or during any variable period, cannot, as we have seen, be calculated from Ohm's law. It is invariably less than it would be if it obeyed that law. The element of time has to be considered, that is, the delay in the current behind the E. M. F., and further, that any variation of the current implies work which, according to the sense of the change, is taken from, or added to, the energy of the current. The law of Ohm has to be modified to meet these cases by the introduction into the expression of a factor whose value depends on the conditions of the circuit and on the time. We apply this factor to Ohm's formula. It is then no longer a simple expression, but Ohm's law extended, or as Dr. J. A. Fleming calls it, when the factor becomes complex and troublesome "Ohm's law glorified." In circuits in which there exists a varying E. M. F., we have in place of Ohm's law, Helmholtz's well-known equation:

$$i = \frac{E}{R}\left((l - e - \frac{t}{T} \right)$$

In words this equation means that the current at any instant is equal to the current which would flow if there was no self-induction, less a quantity depending on the induction and resistance of the circuit, and also on the time from the instant when the circuit was made. A final solution of this equation when the E. M. F. varies periodically is:

$$i = \frac{E}{\sqrt{R^2 + p^2 l^2}} (\sin p\, t - \theta)$$

where p is 2π times the frequency of the current, and θ an angle, whose tangent is the ratio of $p\,L$ to R. To account for the diminution of the current in the variable state, the factor introduced into Ohm's law may be regarded as diminishing the impressed E. M. F. as in Helmholtz's expression, or as increasing the resistance in some way, as in the second equation. In practice the last form is more convenient, and we have in the denomination of the mathematical expression of Ohm's law thus modified a quantity to which the name impedance has been given, composed of the ordinary Ohmic resistance and a term inductive in character called the inductive resistance. As Helmholtz's equation shows an induction E. M. F. acts in opposition to the impressed E. M. F. As work is involved we might expect this result from conservation of energy. Such an opposing reaction is a counter E. M. F. Hence any work done in a circuit, such as electrolytic action, heating or cooling a junction, or moving a magnet, is a counter E. M. F., since it gives rise to an E. M. F. that opposes the original.

It follows that Ohm's law must be modified not only when there exists an induction E. M. F., but also when there is interposed in the circuit a counter E. M. F. due to any cause.

Whatever be the nature of the current, we find that the expression for its value, no matter how complex, retains the general features of Ohm's law. In all cases it may be resolved into two factors, one representing the value the current would have were the instantaneous conditions to continue—Ohm's law pure and simple—the other dependent upon the conditions under which the changes are taking place, and properly considered as modifying the first.

ON POLYPHASAL GENERATORS.—II.[1]

BY M. I. PUPIN, PH. D., COLUMBIA COLLEGE.

Consider now n iron ring cores of exactly the same dimensions and made of the same material. Let ρ be the reluctance of each ring. Let each of the n coils be interlinked with one of the iron rings; we shall have n homogeneous magnetic circuits, and as long as the magnetization of these rings is considerably below the saturation point we shall have

$$\frac{4\pi s c_1^1}{\rho} + \frac{4\pi s c_2^1}{\rho} + \dots\dots\dots\dots + \frac{4\pi s c^1_n}{\rho} = 0$$

That is to say, the magnetic induction in the n magnetic circuits obeys the same law as the n electric currents; we can therefore employ the method of polyphasal connection for the magnetic circuits also and we obtain what the Germans call a Verkettung der Magnetischen Ströme, which may be translated into English by a more accurate expression: Polyphasal *coupling* of magnetic circuits. A transformer constructed on this principle may be called a *coupled transformer.*

A simple consideration will show that the field rotates around the axis of the ring B synchronously with the rotation in the generator which produces the impressed E. M. forces. Consider the armature of the generator. Since the ampere turns on one side of the neutral plane are always equal and opposite in sign to the ampere turns on the other side of this plane it is evident that the magnetic field due to the ampere turns in the armature is fixed in space and perfectly symmetrical with respect to the plane of symmetry PP^1. We can therefore say that this field, though *fixed in space, rotates with respect to the armature* with the *same angular* velocity with which the armature rotates in space. The distribution of the ampere turns over the stationary ring B being at any moment the same as that over the armature ring, it follows that the magnetic field of B also rotates with respect to B synchronously with the rotation in the armature. An inspection of the diagram in Fig. 4 will show that when the rotation in the generator is reversed the rotation of the field B will also be reversed.

The strength of the rotating magnetic field will vary in strength because the strength of the two equal magneto-motive forces which are working in multiple arc will vary. The following simple consideration will show us the law of this variation. Two cases must be considered separately. First, when n is an odd number; secondly, when n is an even number.

CASE 1.

A simple definition will save me the tedious repetitions of long sentences. I define the sum of all the electromotive forces generated in all the turns which are at any moment on the same side of the neutral plane of the generator as the resultant impressed E. M. F. at that moment. The magnetomotive force of the rotating field will evidently vary according to the same law as the resultant impressed E. M. F. To find the law of variation of the resultant impressed E. M. F., consider the armature of the generator when the angle θ of coil 1 is zero. To make the reasoning shorter, I make now the angular width of each coil equal to $\frac{2\pi}{n}$, so that the n coils completely cover the ring, which makes $\alpha = \frac{\pi}{n}$. If this angular width is smaller, then a simple consideration will show that the law of variation which I am about to deduce will be exactly the same. In the position just mentioned, the coils 1, 2, 3, ... $\frac{n-1}{2}$ will all be on the same side of the neutral plane, whereas coil $\frac{n+1}{2}$ will be just half on one side and half on the other side of this plane. There is no electromotive force generated in this coil. As the above-mentioned angle θ begins to increase from zero, coil $\frac{n+1}{2}$ begins to contribute to

1. Read at the sixty-second meeting of the American Institute of Electrical Engineers, New York, December 16th, 1891.

the resultant impressed E. M. F., but this contribution is just counterbalanced by the loss due to the entrance of coil n into the opposite region of the neutral plane. The variation in the resultant impressed E. M. F. is therefore due solely to the change of position of the turns in the coils 1, 2, 3, ... $\frac{n+1}{2}$, or on one side and the corresponding turns on the other side of the neutral plane. This will be the case until coil $\frac{n-1}{2}$ has completely passed to one side of the neutral plane and coil n is just bisected by it. During this interval Θ has increased from zero to $\frac{1}{2}\,\frac{2\pi}{n}=\frac{\pi}{n}$. The value of the resultant impressed E. M. F. at any moment during this interval is easily found. Denote it by E, then

$$E = e_1 + e_2 + \dots\dots e_{\frac{n-1}{2}}$$

$$= K\left\{\sin\left(\theta+\frac{\pi}{n}\right)+\sin\left(\theta+\frac{\pi}{n}+\frac{2\pi}{n}\right)+\dots\dots\right.$$

$$\left.+\sin\left\{\theta+\frac{\pi}{n}+\left(\frac{(n-1)}{2}-1\right)\frac{2\pi}{n}\right\}\right\}$$

$$= K\left\{\sin\left(\theta+\frac{\pi}{n}\right)+\sin\left(\theta+\frac{\pi}{n}+\frac{2\pi}{n}\right)+\dots\dots\right.$$

$$\left.+\sin\left\{\theta+\frac{\pi}{n}+\left(\frac{n-3}{2}\right)\frac{2\pi}{n}\right\}\right\}$$

$$= \left\{\frac{K_1\sin\left(\theta+\frac{\pi}{n}+\frac{n-3}{4}\,\frac{2\pi}{n}\right)}{\sin\frac{\pi}{n}}\right\} = K_2\sin\left(\frac{\pi}{2}+\theta-\frac{\pi}{2n}\right)$$

$$= K_2\cos\left(\theta-\frac{\pi}{2n}\right)$$

It is evident that the resultant impressed E. M. F. E varies during the interval from $\theta=0$ to $\theta=\frac{\pi}{n}$ just like $\cos\left(\theta-\frac{\pi}{2n}\right)$; that is to say it varies just like a simple harmonic. When $\theta=\frac{\pi}{2n}$, E reaches a maximum which is equal to K_2, it has a minimum both when $\theta=0$ and when $\theta=\frac{\pi}{n}$; each of these minima equals $K_2\cos\frac{\pi}{2n}$. The ratio of the minimum to the maximum value equals $\cos\frac{\pi}{2n}$. For a three-phase system this ratio is .866, and it diminishes very rapidly as n increases. It is evident that after θ has reached the value $\frac{\pi}{n}$ the armature is, as far as concerns the resultant impressed E. M. F. in exactly the same position as at the start when $\theta=0$. We conclude therefore that E has $2\,n$ equal

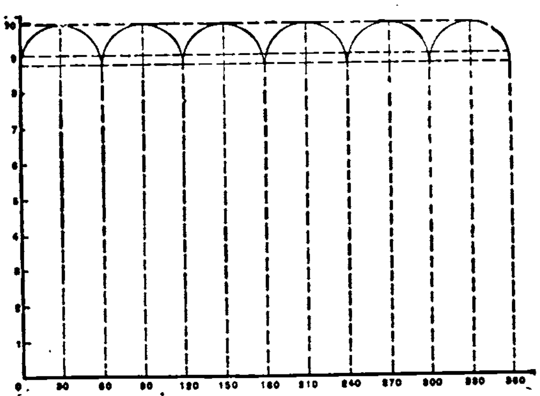


FIG. 5.

maxima and $2\,n$ equal minima during each revolution of the armature. In diagram Fig. 5 these fluctuations of E for a three-phase system are represented graphically.

CASE 2.

The same relations hold good when n is even. The maxima take place when $\theta=0,\ \frac{2\pi}{n},\ \frac{4\pi}{n},\ \dots\dots$ The minima when $\theta=\frac{\pi}{n},\ \frac{3\pi}{n},\ \frac{5\pi}{n},\ \dots\dots$ and the ratio of any minimum to any maximum is $\cos\frac{\pi}{n}$. Since the magneto-motive force varies according to the same law as the resultant impressed E. M. F., it follows that the strength of the rotary magnetic field fluctuates periodically, having $2\,n$ equal maxima and $2\,n$ equal minima during each revolution and the ratio of any minimum to any maximum equals $\cos\frac{\pi}{2n}$. That is, when n is odd, but when n is even then there are n maxima and n minima and the ratio of any minimum equals $\cos\frac{\pi}{n}$.

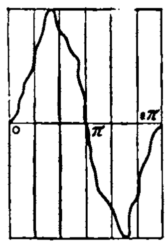


Fig. 6.

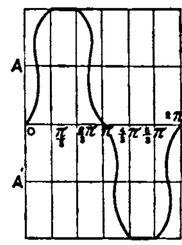


Fig. 7.

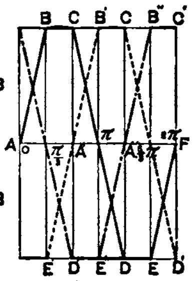


Fig. 8.

A polyphasal generator of this kind would produce a rotary magnetic field of constant strength only when $n=\infty$. For a three phase system the maximum variation would be nearly 14 per cent. of the maximum value. This agrees perfectly with Mr. Dobrowolsky's calculations, but I fail to see how these calculations could justify any one to assume that they hold good for all types of polyphasal generators[1]. The generator which we have considered could be actually constructed but its output would be so small in proportion to its size that we may dismiss it at once as an impracticable machine. We can make it practicable by substituting for the non-magnetizable ring which carries the armature coils a laminated iron ring and for the uniform magnetic field the magnetic field of a well made field magnet with its pole-pieces placed with respect to the armature coils in any one of the various ways sanctioned by practical experience. But in a generator of this kind the resultant impressed E. M. F. will no longer vary according to the law which I have pointed out a little while ago. To be sure, we shall still have the same number of maxima and minima, as may be inferred readily from our knowledge of the shape of the E. M. F. curve of a continuous current dynamo. We all know that this curve is not in general a straight line, but a wave line having as many maxima and as many minima as there are sections in the commutator. But the ratio of the maxima to the minima is no longer an a priori calculable quantity. If we knew the mathematical relation between the intensity of the field at any point of the armature surface and the co-ordinates of this point with respect to the neutral plane then we could calculate that ratio, but the amount of experimental and practical work involved in this problem would be very great. A much easier and practically much more important problem is to determine the conditions which must be fulfilled in the construction of a polyphasal generator, in order that it may be capable of producing a rotary magnetic field of constant intensity in the simplest possible way, that is, without the application of brushes and commutators. Mr. v. Dolivo-Dobrowolsky seems to think that the three-phasal generator is incapable of doing that, for he distinctly says that such a generator necessarily produces a rotary magnetic field whose strength varies 14 per cent. He also states that (evidently to obviate these fluctuations) the Allgemeine Elektricitaets Gesellschaft employ a method of transmitting currents of smaller differences of phase than one-third of the period through three wires. In this point they claim to be ahead of Tesla, Bradley, Haselwander and Wenstrom. In fact if one is not exceedingly careful in the perusal of Dobrowolsky's discussions of this subject he will be lead to believe that the rotary field in some of Tesla's motors varied as much as 40 per cent. and certainly not less than 14 per cent. I do not think that Mr. Dobrowolsky wishes to be understood as holding that opinion; for neither he nor anybody else excepting Tesla himself can know what these variations were. The number of phases employed tell us nothing definite about the range of these variations.

A polyphasal dynamo which is capable of producing a rotary magnetic field of constant intensity must be constructed in such a way that its resultant magneto-motive force must remain constant as long as speed and the magnetic field of the field magnets remain constant. As long as the variable electromotive force developed in each coil follows the law of a simple harmonic that result can never be accomplished by a finite number of phases,

1. M. v. Dolivo-Dobrowolsky: Der Drehstrom und seine Entwickelung; Officielle Ausstellungs Zeitung, Electricitaet, Heft 12.

but it may, perhaps, be accomplished by producing in each coil of the generator a variable electromotive force which varies according to some definite complex harmonic law. In a well-made commercial machine the electromotive forces developed in the various turns of the armature always vary according to some such a law. *The form of this complex harmonic law depends on the form of the magnetic field of the field magnets and also on the distribution of the coils over the armature.* The problem that remains to be investigated consists therefore of three parts: 1st. What must be the particular form of the complex harmonic E. M. F. developed in each coil of a polyphasal generator, in order that both the condition of continuity be fulfilled and also that the resultant impressed E. M. F. be continually constant. 2d. What form of the magnetic field of the field magnets will be capable of producing such an E. M. F. 3d. Can a continually constant resultant E. M. F. produce a rotary field of constant strength.

1st. The first part of this problem is purely mathematical. In a paper read before the New York Mathematical Society I indicated a method of discussing this part in a general way, and worked out completely two particular cases, namely, the cases of a three and four phasal system. The paper is given in the appendix.

2d. For a three-phasal system the form of the complex harmonic E. M. F. given in Fig. 7, will satisfy all the conditions. The form A, B, C, D, E, F, given in Fig. 8, is only a particular case and ought to be aimed at in the construction of the machine.

When there are only three turns within a space through which the armature moves with respect to the field during the time that corresponds to a complete period as in the case of the Lauffen generator (see Figs. 11 and 12), then the field of the field-magnets must be constant in intensity during an angle which corresponds to one-sixth of the period. I have indicated that in the diagram Fig. 9. In the case of bipolar three-phasal generators as indicated in the diagram Fig. 10, where we have six coils, the diametrically opposite pairs being connected in series, the pole faces must have an angular width of 120 degrees and the field must be constant in intensity within the region bounded at any moment by the armature and the pole faces. This is a practical problem offering no serious difficulties judging from the experimental results obtained by S. Thompson, Isenbeck, Mordey and others, and also from the experimental results obtained lately by a graduate of our school, Mr. Freedman, John Tyndall Fellow of Columbia College.

The curve of impressed E. M. F., which must be produced in the case of a four-phasal generator is given in Fig. 13, and needs no further commentary. Larger number of phases offer no special advantages whereas the disadvantages arising from employing a large number of phases are self-evident.

3d. When a coil in which a simple harmonic E. M. F. is developed is closed by a resistance, whether self-inductive or non-self-inductive, the current which is set up in the closed circuit will be a simple harmonic, having therefore all the characteristics of the impressed E. M. F. This, however, is not necessarily the case when the impressed E. M. F. is a complex harmonic. A complex harmonic E. M. F. is composed of a large number of simple harmonic E. M. forces of different frequencies, all the higher frequencies being multiples of the fundamental frequency. When, therefore, a coil in which a complex E. M. F. is generated, is closed by a conductor, and the current is started, the current will be also

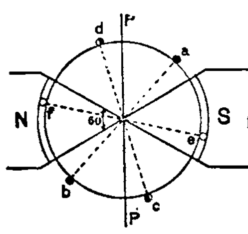


Fig. 9

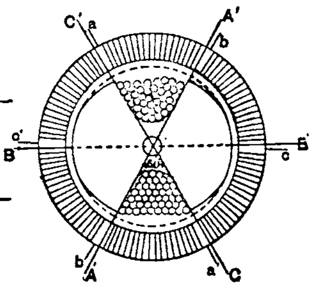


Fig. 10.

a complex harmonic, each simple harmonic component of the complex harmonic E. M. F. producing its own simple harmonic current which is a component of the resultant complex harmonic current. But since the component simple harmonic E. M. forces have each a different frequency, it follows that they will have a different impedance and the shifting of phase will be also different for each component current, currents of higher frequency having a larger shifting in phase and also the ratio of the amplitude of any one of the component currents to the amplitude of any other component of lower frequency, being smaller than the ratio of the amplitudes of the corresponding component E. M. forces. In this respect the propagation of the complex harmonic current-wave resembles very much the propagation of a complex harmonic sound-wave or a complex harmonic light-wave through an absorptive medium like air. The component simple harmonic waves of light and sound will in general suffer the less through the transmission, the longer their wave-length. Just as the sound and light-waves, after such a transmission, lose a great many characteristics of the original vibration which produced them, so an electric wave in its transmission through a conductor possessing ohmic resistance and electromagnetic, not to speak of the

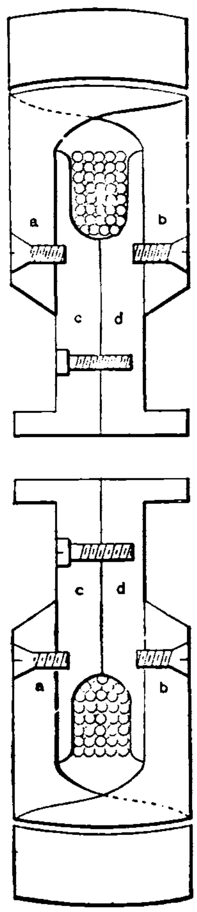


Fig. 11.

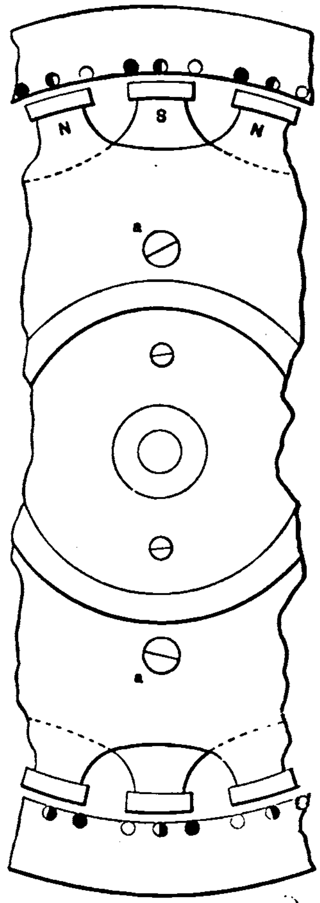


Fig. 12.

electrostatic, inductance will lose a great many characteristics of the impressed E. M. F.

To put this into simple symbolic language of mathematics,

Let L be the coefficient of self-induction of the circuit,

" R be the total resistance,

" $K \sum_{1}^{\infty}{}_{m} a_m \sin m\,p\,t$ be the complex harmonic impressed E. M. F. where $p = 2\,\pi \times$ fundamental frequency,

" x be the value of the current at any moment t.

We shall have, then,

$$L \frac{d\,x}{d\,t} + R\,x = K \sum_{1}^{\infty}{}_{m}\, a_m \sin m\,p\,t.$$

The solution of this differential equation gives

$$x = K \sum_{1}^{\infty}{}_{m} \frac{a_m}{\sqrt{R^2 + m^2\,p^2\,L^2}} \sin (m\,p\,t - \varphi_m)$$

$$\text{where } \tan \varphi_m = \frac{m\,p\,L}{R}$$

The current x is a complex harmonic, its component simple harmonic currents being

$$x = x_1 + x_2 + \ldots\ldots + x_m + \ldots\ldots \textit{ ad infin.}$$

$$\text{The current } x_a = \frac{K\,a_a}{\sqrt{R^2 + a^2\,p^2\,L^2}} \sin (a\,p\,t - \varphi_a)$$

$$\tan \varphi_a = \frac{a\,p\,L}{R}$$

Let E be the impressed E. M. F., then

$$E = e_1 + e_2 + e_3 + \ldots\ldots + e_m + \ldots\ldots \textit{ ad infin.}$$

The component simple harmonic E. M. F. e_a is given by

$$e_a = a_a \sin a\,p\,t$$

These relations give an exact quantitative expression to the preceding physical description.

These considerations made me hesitate at first in taking as granted that a polyphasal generator producing complex E. M. forces, such as I deduced mathematically in the course of my paper, would be capable of producing a rotary magnetic field of constant intensity. But I was glad to find out that my hesitation was groundless, at any rate in certain particular cases.

Consider the three-phasal generator whose diagram is given in Fig. 10. Take, now, another *well-laminated* armature wound in a similar way as the armature of the generator. Connect the three pairs of coils of the generator to the three sets of coils in armature 2. We shall have three separate circuits, the ohmic resistance and the self and mutual inductance in each circuit being the same. Denote by E_1 E_2 E_3 the three complex harmonic E. M. forces in the three circuits. Let x, y, z be the currents at any moment. Then we shall have

$$L\frac{dx}{dt} + M\frac{dy}{dt} + M\frac{dz}{dt} + Rx = E_1,$$

$$L\frac{dy}{dt} + M\frac{dx}{dt} + M\frac{dz}{dt} + Ry = E_2;$$

$$L\frac{dz}{dt} + M\frac{dx}{dt} + M\frac{dy}{dt} + Rz = E_3.$$

But since $E_1 + E_2 + E_3 = 0$ for all values of t it follows that

$$L\frac{d}{dt}(x+y+z) + 2M\frac{d}{dt}(x+y+z) + R(x+y+z)$$

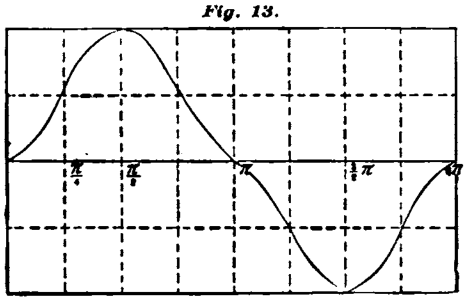
$= 0$ for all values of t. This can be true only if

$$x + y + z = 0$$

for all values of t. That is to say, the currents fulfill the condition of continuity. We can therefore employ the method of polyphasal connection. Substitute now in the first of the three differential equations

$$z = -(x+y)$$

Fig. 13.



and we obtain

$$(L-M)\frac{dx}{dt} + Rx = E_1 = K\sum_1^\infty{}_m\, a_m \sin mpt$$

The solution of this equation gives

$$x = K\sum_1^\infty{}_m \frac{a_m}{\sqrt{R^2 + m^2p^2(L-M)^2}}\sin(mpt - \varphi_m)$$

Similarly,

$$y = K\sum_1^\infty{}_m \frac{a_m}{\sqrt{R^2 + m^2p^2(L-M)^2}}\sin\left\{m\left(pt + \frac{2\pi}{3}\right) - \varphi_m\right\}$$

$$z = K\sum_1^\infty{}_m \frac{a_m}{\sqrt{R^2 + m^2p^2(L-M)^2}}\sin\left\{m\left(pt + \frac{4\pi}{3}\right) - \varphi_m\right\}$$

In the case under consideration both L and M are pretty small when the metallic parts of the magnetic circuits are near the saturation point, so that $L - M$ is exceedingly small, and $m^2p^2(L-M)^2$ will be very small in comparison to R^2 even for large values of m, unless the frequency is very high. Also, since

$$\tan\varphi_m = \frac{mp(L-M)}{R}$$

φ_m is exceedingly small unless p is very large, we shall have for moderate frequency generators

$$x = \frac{K}{R}\sum_1^\infty{}_m\, a_m \sin mpt$$

and similarly for y and z. The same method of reasoning may be easily applied to any number of phases. The mathematical operations will be considerably larger, but still the same results will be deduced without much difficulty.

That is to say, the curves for the currents are the same complex harmonics as those of the impressed E. M. F. The currents therefore produced a rotary magnetic field of nearly constant intensity; this is evidently true even if these currents produce a saturation in the iron part of the magnetic circuits.

The resemblance between a polyphasal generator and a continuous current dynamo, which these relations bring into view, is exceedingly striking and instructive.

The advantages gained from a polyphasal generator capable of producing a rotary magnetic field of constant intensity would be very much diminished indeed if it should turn out that it is impossible to devise a simple and efficient method of transformation[1] by means of which the polyphasal system of currents producing a rotary field of constant intensity (a constant rotary field system) can be transformed any number of times without losing its distinguishing characteristic. I intended to discuss this problem also this evening, but having been disappointed by the mechanician who is constructing several pieces of apparatus illustrating this problem, I decided to postpone this discussion to some other time.

To sum up:

1st. The consideration of simple harmonic impressed E. M. forces does tell the whole story of the polyphasal generators.

2nd. The law of variation of the strength of the rotary magnetic field which a polyhasal generator can produce is not as simple as Mr. v. D. Dobrowolsky thinks.

3rd. Polyphasal coupled transformers must be worked at *low magnetizations* and *low frequencies*, otherwise they will not satisfy the condition of continuity. It follows, therefore, that they will *probably be very large for the output which they can give.*

4th. It is very probable that nearly constant rotary magnetic fields can be produced in practice by a small number of phases (not more than three) by properly shaping the curve of the impressed E. M. F.

Letters to the Editor.

THE "JEWEL" INCANDESCENT LAMP TRADE-MARK.

In looking over the list of new incorporations, in a recent issue of the *Chicago Evening Post*, I noticed that certain parties, wholly unauthorized by me, have made application to the Secretary of State for the incorporation of a company for the manufacture of incandescent lamps, this company to be known as the "Jewel Incandescent Lamp Company."

The purpose of these parties, whoever they may be, is evidently to appropriate the name "Jewel" as applied to incandescent electric lamps; and for the purpose of defrauding me of my trade-mark, which I have extensively advertised and introduced, and which name has become very valuable.

The name or trade-mark "Jewel" as applied to incandescent lamps, originated with me, and is my personal property. Any attempts by other parties to pirate this name, is not only an injustice to me, but to users of the "Jewel" incandescent lamp.

By kindly giving this publication in your valuable paper, you will greatly oblige.

Wm. Hood.

Chicago Dec. 24, 1891.

A TELEPHONE TRANSMITTER WITH METAL SPRINGS.

In The Electrical Engineer of Dec. 19th, a telephone transmitter without electrodes is illustrated and described.

In June, 1889, I constructed and operated transmitters based on this principle.

The springs used by me were metal; sometimes a round wire was employed; at other times a ribbon was coiled into a spiral and used.

Transmission was perfect, but not as loud as I hoped for. Carbon was suggested to me, but I had at that time no facilities for working it and abandoned it after repeatedly failing to construct a helix of it.

B. C. W.

Elmira, N. Y., Dec. 21, 1891.

MR. MACKAY AS SANTA CLAUS AGAIN.

A few days before Christmas Mr. J. W. Mackay, president of the Commercial Cable Company, instructed Vice-president Ward to pay to each and every employé of the company half a month's salary as a Christmas bonus to mark his appreciation of their cheerful and co-operative efforts during the year. He also sent the following cable to the boys: "I want the staff to aid me in keeping the 'Commercial' to the front. Let it always retain its reputation as the 'leading cable company—leading in accuracy, leading in speed, leading in staff.'

"I wish you and your families a Merry Christmas and a Happy New Year."

1. Not only transformation of the power supplied by the generator into electrical power of higher or lower potential, but also transformation of this power into mechanical power. This, of course, leads into the discussion of rotary fields produced under practical conditions.

Legal Notes.

INCANDESCENT LAMP LITIGATION—THE UNITED STATES ELECTRIC LIGHTING CO. vs. THE EDISON LAMP CO.—III.

ARGUMENT OF GEORGE H. CHRISTY FOR THE UNITED STATES COMPANY.

THE closing argument for the complainant was made by George H. Christy, Esq., of Pittsburgh. Mr. Christy said he would commence with a word in reference to the general equities of the case. He understood his brother Betts to allege that the invention in question had been given to the public; first by Sawyer and Man and second by Maxim, and that this had been done at a date such that Weston was barred from procuring a valid patent, and therefore stood in no position of equity in this court. Moreover, he thought his brother Betts clearly implied that his clients were entitled to the benefit of any equity asserted on behalf of Sawyer and Man or of Maxim, but in that opinion he apprehended that his brother had made a serious mistake as regarded the doctrine of equity. Assuming for the present that he was correct in what he had said of Sawyer and Man, it merely proved that they had made something known to the public in the assertion of an adverse right belonging to themselves. Could the public take anything by such a disclosure? or could this defendant take anything as a matter of equity? So also in the case of Maxim; the defendant was in no position to assert any equity as regards this invention. It did not claim under either of those parties. It could only assert an equity as part of the general public; but the general public could be entitled to no equity in view of anything that had been done by Sawyer and Man, or by Maxim, for what they had done had been under a claim of title and exclusive right of their own. Moreover, the party who was claiming this equitable right was the party charged with being the infringer, but an infringer (if it could be shown that defendants did infringe), was in no position to assert equities by virtue of anybody else's title.

The claim of complainant's patent was for "building up said core with carbon obtained and deposited upon the same by and during the operation of electrically heating said core." Mr. Christy showed by extracts from the specification that the term "building up" included any result whereby the carbon which was separated from the surrounding liquid, vapor or atmosphere, was put on, or into, or anywhere with reference to the conductor so as to impart to it the qualities desired for a burner for an incandescent lamp. His brother Betts had said that the words "for incandescent lamps" in the claim must be rejected as surplusage, or used as a term of limitation; if surplusage, then it was anticipated by Despretz; if, on the other hand, it was a limiting phrase, then the invention had not been complete until Weston had found out, by actually trying a treated carbon in a lamp, that it was suitable for that purpose. He (Mr. Christy), believed the latter meaning to be correct; but his brother Betts had been in error in his conclusion that the invention could not be completed until Weston had found out that it might be used as a commercial success in an incandescent lamp. That was not the standard of invention at all. The standard by which it was to be judged was this: Was the carbon pencil, thread, filament, stick, whatever it was, in better condition for that use after treatment than it was before? If so, the conditions of invention had been practically fulfilled, and it had been so because Weston had progressed far enough to ascertain that fact. Mr. Christy then read from Fontaine's book of 1877, a statement that the examination of incandescent carbons through a strongly colored glass had rendered their defects visible. That test was a part of the state of the art as it then existed. Would Mr. Weston then have had any difficulty, looking at his carbon, before and after treatment, through a smoked glass, to ascertain whether the carbon had been improved? And if he had found—as his testimony had said that he did—that such was the case, the invention had then, if he (Mr. Christy) correctly understood the law, been complete and perfect at that time. The testimony of Mr. Vandergrift was that the test of visual inspection was the one used to-day, and the only reliable one known in the art.

His brother Betts had contended that there had been no sufficient proof of infringement, and that the Weston process, so far as it had related to the use of oil, had never been commercially used. "Why,"—said Mr. Christy,—"his own client had used it." That use had been the very infringement complained of. He then read from the testimony of defendant's employees in confirmation of his statement, and said that it did not lie in the mouth of defendant to say anything about defects of a patent based upon the use of oil, or based on the use of red heat, for it had used both. Defendant had said there was no proof of sale or use. It was not necessary. Defendant was engaged in the business of manufacturing lamps; presumptively, when it had been proven to have made use of a process in its factory, by its workmen, and apparently in the ordinary course of business, it was fair to infer that it had been done for a purpose. Under the law the construction of a thing in a commercial way was a commercial use, but the proofs were that defendant's workmen had put the carbons into lamps. It seemed to him that that testimony made out a clear case of infringement. Defendant contends that it made but a few, but for present purposes the number made was immaterial. When complainant had made out a *prima facie* case, all that was necessary was to prove one act of infringement, and then in case the bill was sustained, to ascertain the extent of infringement.

But the testimony of defendant's employees had shown that the infringing had continued off an on at intervals for months; that carbons not in conformity with the standard had been treated, while those of the proper or desired resistance had not been treated. He would say here parenthetically, that he understood Mr. Edison claimed to have discovered a new material for a filament made from bamboo and to have invented a process for carbonizing his bamboo carbons so perfectly that they did not need this treatment. He then read from an affidavit of Mr. Edison in certain proceedings in Canada, introduced by stipulation into this case, setting forth at length the great difficulties attending the commercial process of carbonizing filaments. It was fair to infer, continued Mr. Christy, from what had been said by Mr. Edison and by his witnesses, that some carbons were made not good enough for use, and that to the extent of those carbons defendant had employed this process. Defendant had said that it had quit using the process, but it had not promised that it would not use it any more. His Honor was aware that a defendant could not take anything by such a pretension as that, unless it appeared that it had gone permanently out of the business and intended to stay out.

Again defendant had said that all that had been done had been experimental, but the testimony had shown that Mr. Holtzer, the superintendent of the works, had directed the electrician to continue the process as to all carbons not up to the standard. Yet defendant contended that the whole thing was an experiment; that they had only done a few, and that there was no proof that any of them ever went into a lamp that was sold.

Turning to another point, Mr. Clarke defendant's alleged expert—he said "alleged," because Mr. Clarke, had admitted that he had had no experience in the treatment of carbon—had been asked whether or not from the testimony of Broadbent and Quimby, a man skilled in the art as it existed in 1877 and 1878, could have manufactured a successful commercial lamp. That was not a correct standard by which to judge of that testimony. It had been taken simply as to certain facts within the knowledge of the witesses, and was not required by any rule of law or practice to be in the nature of a specification; hence the inquiry made of Mr. Clarke was immaterial and irrelevant. Again Clarke had said that Quimby did not say that Weston had told him he was going to put those carbons into electric lamps. It was not necessary to tell a painter that a picture represented a sunset nor to so label it. It was not necessary for Quimby to be told that the thing which he saw done in a glass globe had been intended for an incandescent lamp; he would have known that by seeing the experiment.

Defendants had said that Mr. Edison was entitled to the credit of the successful commercial lamp; that he had made it by getting rid of gases, and by the use of a vacuum, etc., but there were one or two very singular things in this case. His Honor would understand as complainant's view, that Weston was not bound to proceed with his application for a patent until a reasonable probability appeared that he could get some reward by the sale or use of a commercial lamp. So long as no commercial lamp was known in the art, in which his invention could have been used, he had done perfectly right in delaying his application and he had done it for good reasons. Defendants on that statement of facts, had been challenged to prove, if they could, that their inventor, Edison, or anybody else, had had a commercially successful lamp in such a way as to get some equity to itthemselves as distinguished from Weston. If Mr. Edison had been the inventor that they claim, or if he had solved this problem in the fall of 1879, did it not seem probable that the fact would have been proven in this case? To whom had they gone for that credit? Not to Edison, but to Maxim; to the use made by him and the present complainant in November, 1880, and they had tried to bring themselves in as entitled to any benefit which might possibly have arisen in behalf of Mr. Maxim.

(To be continued.)

Appointments, Etc.

MR. B. L. FREEDY, who has been manager of the telephone exchange in St. Paul, has gone to Fargo, Dak., to assume management of the exchange there, while Mr. W. F. Burns, of Fargo, removes to St. Paul.

MR. ALEX. CHURCHWARD, the assistant electrician of the Riker Electric Motor Co. during the past year, has now been appointed general superintendent and electrician of that company.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED DECEMBER 22, 1891.

Alarms and Signals :—

Low-Water Alarm, F. St. Clair, 465,767. Filed April 11, 1891.
A steam low-water alarm, electrically actuated.

Train-Signaling Apparatus, P. Synnestvedt, 465,501. Filed Oct. 13, 1890.
An electric signal, by means of which the conductor of a railway train may readily communicate with the engineer.

Combined Signal and Telephone System, T. W. O'Brien, 465,648. Filed July 20, 1891.
Comprises an organization of electric circuits and appliances enabling a speaking instrument to be employed as a useful auxiliary to the ordinary system of arbitrary bell signals.

Electric Circuit Closer for Burglar Alarms, W. C. Thompson, 465,602. Filed Oct. 19, 1889.
A window sash burglar alarm.

Annunciator for the Supposed Dead, W. H. White, 465,548. Filed Nov. 24, 1890.

Clocks :—

Independent Electric Clock, W. J. Dudley, 465,655. Filed July 11, 1891.

Conductors, Conduits and Insulators :—

Conduit for Electric Wires, H. W. Jones, 465,564. Filed April 1, 1891.
Claim 1 follows:
A conduit for electric wires composed of strips of compacted asbestos fibre, wound in opposite directions, and waterproofing material, and cementing material.

Distribution :—

System of Electrical Distribution, F. A. La Roche, 465,594. Filed Oct. 9, 1890.
Has for its object the equalization of the difference of potential between the leads of an electric light or power circuit.

Means for Turning On and Off Electric Currents, T. C. Smith and B. D. Acker, 465,805. Filed Oct. 1, 1890.
A method of locally controlling an electric light circuit.

Dynamos and Motors :—

Dynamo-Electric Machine, R. Thury, 465,808. Filed Aug. 4, 1891.
A multipolar dynamo having two concentric rows of field magnets with the unlike poles of each series in juxtaposition, a rotatable armature composed of a divided hollow thin iron cylinder covered on the inner face with internal conductors and on the outer face with external conductors, and connections at the respective faces of the armature.

Lamps and Appurtenances :—

Globe-Holder for Electric-Arc Lamps, H. A. Foster, 465,470. Filed Nov. 3, 1890.
A clamping device for attaching globes to arc lamps.

Hanging Device for Arc Lamps, W. K. Howard, Jr., 465,665. Filed Oct. 30, 1890.
An automatic catch for arc lamps.

Electric Arc Lamp, H. C. Waldecker, 465,685. Filed Apr. 8, 1891.
Method of regulating the feed of arc lamp carbons by means of a piston loosely fitted into a tube containing liquid, which checks any sudden movement of the carbon.

Incandescent Electric Lamp Fixture, G. E. Villaret and V. E. Rondel, 465,684. Filed May 23, 1891.

Electric Arc Lamp, H. P. Ball, 465,514. Filed June 13, 1891.
A cut-out for arc lamps, provided with a mechanical lock for holding the circuit closed.

Cut-Out for Incandescent Lamps, H. C. Wirt, 465,508. Filed Mar. 28, 1890.
An automatic short-circuting device for series incandescent lamps.

Measurement :—

Electrical Testing Instrument, R. Varley, Jr., 465,809. Filed Jan. 15, 1891.
A testing instrument for the purpose of locating very minute insulation faults in electric wires.

Metallurgical :—

Electrolytic Apparatus for Treating Metals, E. S. Hayden, 465,525. Filed Nov. 5, 1887.
Claim 1 follows:
In an electrolytic bath having a number of plates unconnected electrolytically excepting through a solution in the bath, and having narrow partitions extending from opposite sides of the bath adapted to hold the plates in a vertical position and out of contact with each other, and stops wholly between the partitions supporting the plates above the bottom of the bath.

Miscellaneous :—

Electric Switch, G. E. Painter, 465,618. Filed Apr. 16, 1891.
A small, compact, and inconspicuous switch for residences, etc.

Rheostat, W. S. Andrews and A. K. Warren, 465,512. Filed Aug. 25, 1891.
A rheostat for electric fan motors.

Electric Snap-Switch, W. S. Andrews, 465,511. Filed May 7, 1891.
A simple and inexpensive construction for the snap-switches.

Electric Switch, H. Barton, 465,444. Filed Dec. 15, 1890.
An electric switch in which, when the connections are made, the contact-piece is locked in position, and can only be released by pressure properly applied at the handle.

Railways and Appliances :—

Electric Railway Trolley, F. J. Sprague and P. O'Shaughnessy, 465,806. Filed Jan. 22, 1889.
A trolley employing a single horizontally-placed spiral spring, for the purpose of keeping an even pressure against the trolley wire.

Electric Railway, W. H. Applegate, 465,613. Filed Nov. 10, 1890.
A conduit railway in which a traveling conductor maintains electrical contact with the main lead without exposing the entire length thereof.

Gearing for Electric-Motor Cars, O. F. Evans, 465,592. Filed Jan. 24, 1891.
A worm-gear for use in connection with high-speed motors on electric cars.

Electric-Railway Trolley, C. S. Foster, 465,469. Filed May 31, 1890.
A mechanism for securing the trolley on the trolley-wire so that it cannot become accidentally detached.

Guard for Trolley-Wire Insulators, F. O. Blackwell, 465,447. Filed May 29, 1891.
The guard for preventing the trolley from striking the insulator, when thrown from the wire.

Telephones and Apparatus :—

Adjustable Support for Telephones, C. H. Gatchell, 465,778. Filed Aug. 26 1891.
An adjustable bracket for telephone receivers.

Society and Club Notes.

THE THOMPSON SCIENTIFIC CLUB, LYNN, MASS.

At the regular meeting of the club the annual election of officers was held. The following were elected: President, J. B. Cahoon; 1st vice-president, H. G. Reist; 2d vice-president, F. C. Bates; secretary, F. Sheible; treasurer, J. B. Barr; librarian, E. D. Priest. Reviewers: Engineering, H. G. Reist; physics, H. S. Rodgers; natural science, J. E. Randall. Executive Committee: Messrs. Randall, Cahoon, Reist, Bates, Barr, Towner, Priest.

The rapid growth of the club is apparent when we consider that it was organized in May, 1889, and moved into its present extensive quarters last February. The reports of officers for the past year showed the club entirely out of debt, with quite a balance in the treasury. At present there are about 100 books and pamphlets in the library, together with 24 subscriptions to current scientific and popular periodicals, the latest addition being the *Century Dictionary*.

The club now numbers 134 members. At the last meeting Prof. Chas. R. Cross was elected an honorary member of the club.

The course of public scientific lectures now being held is in every way a success. The proceeds of this course will go towards fitting up the library of the club.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The subjoined resolution, passed by the international congress committee and the council of the American Institute of Electrical Engineers, is the outcome of the recent visit to New York city of Dr. Elisha Gray of Chicago, chairman of the Committee on the World's Electrical Congress.

Dr. Gray, after several informal interviews with officers and members of the institute, was invited to attend a meeting of the congress committee on December 16, where a mutual exchange of views upon the subject was had, and the result is entirely satisfactory to all parties interested.

Resolved, That the American Institute of Electrical Engineers, having already taken action during the past three years, by correspondence and otherwise, towards the holding of an International Electrical Congress in connection with the Columbian World's Fair, hereby expresses its desire and intention to co-operate, by all means in its power with the World's Congress Auxiliary of the World's Columbian Exposition, through its Electrical Congress Committee, in furthering the gathering of such a congress at Chicago in 1893, and in making it a successful and worthy representation of the best electrical science and practice in all parts of the world.

THE ELECTRIC CLUB.

On New Year's Eve (Thusday) Mr. Joseph Howard, the celebrated journalist and member of the club, will deliver a lecture at the club house entitled "A Plain Talk about Journalism." It may be counted upon as one of his most brilliant efforts, and will be heard by a large audience. The lecture will be followed by a high class musical programme.

THE NEW YORK ELECTRICAL SOCIETY.

At Columbia College, on Wednesday, Dec. 30, before the New York Electrical Society, Mr. A. A. Knudson will read a paper on 'Electrical Fakes." Such a subject is full of interest and amusement, and it will lose nothing at Mr. Knudson's hands.

THE MAGNETIC CLUB.

The annual meeting of the Magnetic Club of New York will be held January 14, at 195 Broadway, for the election of officers and four members of the governing committee.

DID NOT RECEIVE THE ITEM.

An electrical concern recently sent out some lamps with the note that the lamps shipped were "3.6 watts No. 3 base." The shipping list came back with the statement that the lamps had arrived but that the above item had not come to hand.

smaller than the total combined power of the hoists, so that great economy of room as well as of power is had; or the station may be away from the docks entirely. Mr. Williams also proposes to utilize the power plant for lights to facilitate work at night, and has devised some special apparatus for safely lighting the interior of the vessels while being unloaded, as well as the docks. The motor employed by the company is the single-magnet type of 30 h. p. and together with the controlling devices was designed for this special work by Mr. Frank B. Rae, of Detroit.

One great advantage of the Nicholson system is the presence on the tram-car of the operator, who is at all times over the scene of work, and has perfect control of the movements of the car. This obviates the necessity of the signal men used in the steam cable systems. The mechanical parts subject to wear and tear are reduced to a minimum in the electric hoist, and the absence of the boiler and engine plant of the steam systems occupying room valuable for storage of ore, is an important feature. The first cost of construction, the cost of maintenance and the expenditure for labor are all much less with the electric system than where steam cables are used.

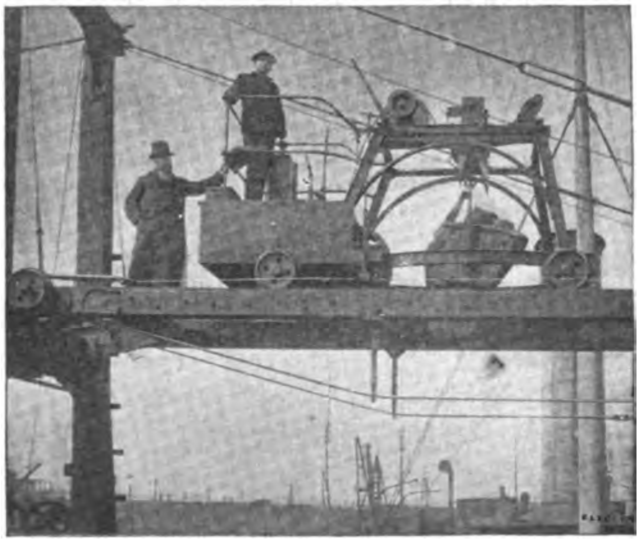


FIG. 2.—THE NICHOLSON ELECTRIC HOISTING AND CONVEYING MACHINE FOR HANDLING FREIGHT ON DOCKS, etc.

A few figures concerning the iron and coal interests of the great lakes may show to what a magnitude the work of loading and unloading vessels has reached on those inland waters.

During six months of navigation in 1890, nine million tons of iron ore was transported by vessels from the mines on Lake Michigan and Lake Superior to ports on Lake Erie, where it was unloaded. At Cleveland alone last year, two million tons of ore were unloaded at the docks, and one million tons of coal were shipped to the upper lake ports. In order to accomplish this amount of work, many of the docks have been equipped with steam systems of hoisting and conveying, at a great expense. The average cost of the ore tramways or "bridges" equipped is $10,000, and oftentimes six of these bridges are placed opposite one vessel for unloading.

These steam hoists only work in the day-time, while the Nicholson system is designed to work at night as well as during the day, thereby reducing the length of time necessary for vessels to remain at the discharging port. In these days of radical changes, time is the most important element to the vessels of lake marine, and with the advent of the "Whaleback" barges and steamers of greater speed and carrying capacity, the terminal companies must equip their docks with hoisting plant giving the greatest dispatch.

The Nicholson system appears to supply this want and not only will many of the docks at the lake ports recognize this and equip with electric hoisting and conveying machines, but other ports where it is desirable to unload merchandise from steamers, such as boxes, casks, bales, etc., and remove the goods to some point for storage more cheaply than by using 'longshoremen, will adopt this economical system.

The Nicholson Electric Hoist Company has been organized by Mr. Williams in Cleveland, and the directors are men largely identified with the shipping and iron mining interests of that region. Mr. C. W. Foote, formerly agent of the Sprague and Thomson-Houston Companies at Cleveland, is the general manager of the company. The mechanical work and bridges will be constructed by the Cleveland Ship Building Company, while the electrical equipment will for some time to come be purchased in the open market.

COMPENSATING RESISTANCES FOR GALVANOMETER SHUNTS.

BY

Charles P. Frey

THE ordinary operation of connecting a resistance commonly called a shunt in multiple with the coils of a galvanometer, and thereby decreasing the current flowing through the instrument, and consequently confining the swing of the needle to an observable range, is too well known to require description. In order to reduce the deflections to known proportions, it is necessary to use coils in both galvanometer and shunt, the resistances of which have an ascertained value. Briefly, the formula for shunts is as follows: If the total current (C) divides between two resistances, the lesser resistance will carry the greater current and vice versa. The proportion of current traveling through the galvanometer will be $C\frac{S}{G+S}$, and the current flowing through the shunt will be $C\frac{G}{G+S}$.

For convenience in calculation, the resistances of shunt coils are usually proportionately adjusted so as to reduce the galvanometric sensitiveness to its $\frac{1}{10}$, $\frac{1}{100}$ and $\frac{1}{1000}$ part.

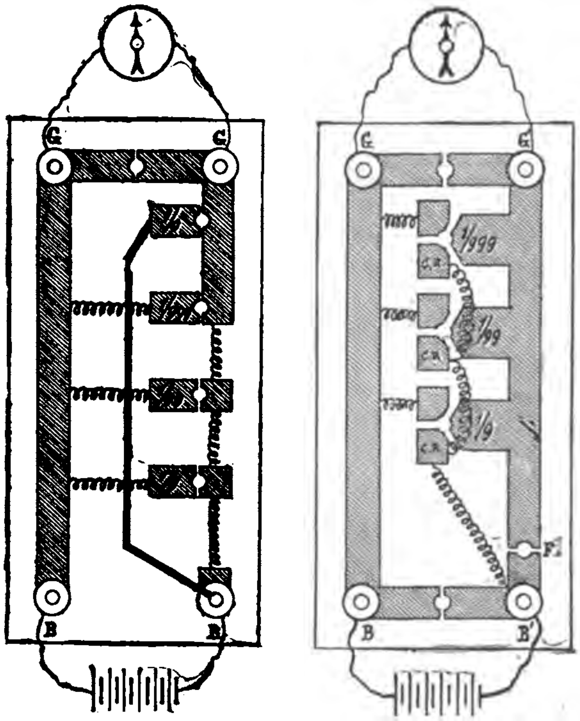
Shunt coils form an important adjunct to a galvanometer, especially when the latter is of the reflecting type, and is to be employed in connection with other apparatus for determining the value of high resistances. When the conditions of lines or the insulating qualities of materials used for covering wires are to be tested, shunts are almost indispensable. In high-resistance measurements, the usual method of employing shunts is to determine the "constant" of a galvanometer by means of the $\frac{1}{1000}$ shunt, and noting the deflection.

The "constant" once determined, the insulation of the line, etc., is generally measured by cutting out the shunt and any resistance that may have been introduced in the circuit, and taking readings with the galvanometer at maximum sensitiveness. An error in the degree of deflection obtained when the shunt is used will hence introduce an error in the basis for calculation. It is therefore evident that it is of intrinsic importance to secure shunts upon the correct adjustment of which dependence can be placed. When purchased from reliable manufacturers, there is usually no cause for apprehension on this score, but nevertheless there is a source of error involved in the use of ordinary shunt coils which, as one writer has it, "introduces an element of vagueness in the result." The fact is, a shunt having a resistance of, for instance, exactly $\frac{1}{9}$ the resistance of the galvanometer, will *not* reduce the deflection to precisely $\frac{1}{10}$, although the formula previously referred to seems to proclaim that such will be the case.

Disproportionate deflections are sometimes correctly attributed to lack of proper adjustment in the position of the scale. Obviously it is essential to adjust the scale so that it will be perpendicular to the reflected beam when the latter is not moving, but even this precaution will not eliminate the discrepancy.

Several prominent writers on the subject of electrical "testing," among others, Sprague, Ayrton, Gordon and Kempe, have mentioned the peculiar characteristic of shunts referred to, but only one author (Kempe, as far as the writer of this article can discover) has treated the subject exhaustively. In his excellent handbook on Testing, Kempe explains as follows :

. . . . "When a shunt is introduced between the terminals of a galvanometer which reduces its sensitiveness to one-half, or a shunt equal to the resistance of the galvanometer, it will not exactly halve the current passing through the instrument. If we used a tangent galvanometer, we would find, if the deflection without the shunt was 40 divisions on the tangent scale, the introduction of the shunt would not bring the deflection down to 20, but some deflection greater than 20. The reason of this is that the introduction of the shunt reduces the total resistance in the battery circuit, and consequently increases the strength of the current passing out of the battery. It is this increased current, then, which splits between the galvanometer and shunt, and not the original current. To make up for this decreased resistance caused by the introduction of the shunt, it is necessary to add in the battery-circuit a *compensating resistance* equal in value to the amount by which the original resistance was reduced."



KEMPE'S ARRANGEMENT. FREY'S ARRANGEMENT.

FIGS. 1 AND 2.—COMPENSATING SHUNTS.

In addition to the above extract, Kempe devotes several pages of his work to mathematical considerations of the subject, and also describes and illustrates a compensating shunt-box of his own invention, a highly ingenious contrivance, which will be explained in this article.

The value of a compensating resistance (if introduced in the battery-circuit) must, in order to maintain a uniform current, be equivalent to the difference between the resistance of galvanometer and shunt in multiple, and that of the galvanometer only. When the resistance of the galvanometer is, for instance, 5494.5 ohms, and its sensitiveness is to be reduced to its $\frac{1}{10}$ part, the value of the shunt will be $5494.5 \times \frac{1}{10 - 1} = 610.5$.

The resistance of the divided circuit (galv. and shunt) will be $\frac{G\,S}{G + S} = 549.45$. The compensating resistance will be

$$5494.5 \times \frac{10 - 1}{10} = 4945.05$$

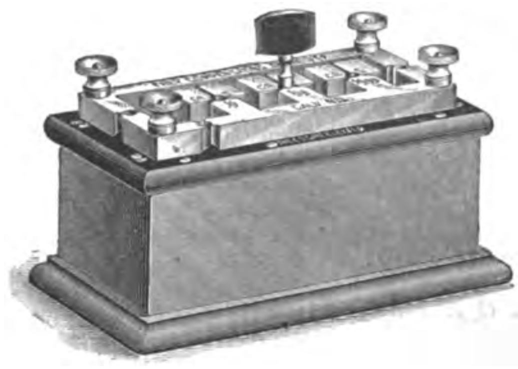


FIG. 3.—FREY COMPENSATING SHUNT.

Or, the compensating resistance (C) may be determined as follows: $C = G - \frac{G\,S}{G + S}$. In simple arithmetic the compensator equals, in this case, $5494.5 - 549.45 = 4945.05$.

Kempe's device for combining shunts and compensating resistance so that both may be thrown in circuit by means of one plug, is illustrated by Fig. 1. By following the path of the connections it will be seen that by placing a plug in the hole marked $\frac{1}{0}$ the shunt is cut out. Now removing the plug to the $\frac{1}{999}$ position will throw in circuit a shunt equal to $\frac{1}{999}$ of G and also introduce in the battery circuit a compensator consisting of three branches connected together in series, which jointly equal $\frac{999}{1000}$ of G.

Placing the plug in the $\frac{1}{99}$ position will, however, necessitate a change in the ratio of the corresponding shunt coil, since that part of the compensating coil which is between the $\frac{1}{99}$ and $\frac{1}{999}$ contact blocks, is now added to the *galvanometer circuit*. Hence this resistance becomes an inconvenient factor which must be taken into consideration in determining the value of the $\frac{1}{99}$ shunt. When the $\frac{1}{9}$ shunt is to be used, matters are still further complicated, as will be seen by referring to the diagram. The formula for determining the value of shunts and compensators of this type may be found in Kempe's treatise. The instrument itself has not however come into general use, owing probably to the intricate adjustment required, and the difficulty involved in testing the various requisite resistances. Figs. 2 and 3 illustrate a shunt box with compensating resistances which (the writer believes) embodies all of the essential features of Kempe's arrangement without the attendant complications already referred to. Its construction is exceedingly simple, and can be at once understood by tracing the path of connections on Fig. 2. It consists primarily of three shunt coils of usual proportionate resistances. These can be successively thrown in circuit together with suitable compensating coils, by means of a single plug, which, when inserted, connects in each case two independent blocks with a common conductor. The battery wires are connected at B and B' as shown and the galvanometer at G and G'. Now if one of the shunt coils is in use and an extra plug (not required for actual tests) be inserted at F, the compensating coils will be short-circuited, and since the principle of adjusting the shunt coils to $\frac{1}{9}$, $\frac{1}{99}$, and $\frac{1}{999}$ (or any other preferred fraction) of the galvanometric resistance is maintained throughout, the box will not, under the given conditions, differ from one of conventional pattern as far as the shunt coils are concerned. When, however, the extra plug at *F* is removed, the path of the current from the battery will be from the insulated block at *B′ through the compensating resistance* to the nearest block marked *C R*. If the plug is inserted at $\frac{1}{9}$, the current will then split between the $\frac{1}{9}$ shunt and galvanometer coil. Between the first block *C R* and the second is another compensator connected in series with the first one, and between the second and last block is a third coil connected in series with the two others.

Since each block will be insulated when unplugged, the wire used for the $\frac{1}{9}$ compensator may form part of the compensator for the $\frac{1}{99}$, etc.

The resistance of the three parts of the compensating coils is determined as follows: Let *G* (the galvanometric resistance) be 5494.5 ohms. The $\frac{1}{9}$ shunt compensator will then be 4945.05 ohms (see preceding formula). The total resistance of the $\frac{1}{99}$ compensator will be 5439.555; but since part of this resistance is furnished by the $\frac{1}{9}$ compensator, the resistance of the coil between the first and second blocks marked *C R* will be 5439.555 — 4945.05 = 494.505, while the resistance between the second and third block marked *C R* will be: 5489.0055 — 5439.555 = 49.4505. Hence it is obvious that the resistance of the entire circuit will remain uniform, whether shunt coils are used or not. When it is desired to use the galvanometer at maximum sensitiveness, the plug is removed from the shunt coils and inserted at *F*. This simultaneously cuts out both shunt and compensating resistance and permits the current to travel directly to the galvanometer, through the brass bars.

Removing the plug entirely leaves the circuit open. To short circuit the battery and leave the galvanometer open, the plug is placed between *B* and *B′* and finally when experiments are concluded, the galvanometer can be short circuited and the battery circuit left open by placing the plug between *G* and *G′*.

In addition to general ease of manipulation, this form of compensating shunt has the advantage of being easily and quickly tested for accuracy with the aid of a rheostat and bridge. The resistances of the shunts only can of course be tested by connecting *G* and *G′* and shifting the plug. By connecting at *B′* and *G′* the compensating coils can be measured in the same manner.

GREELEY LABORATORY, GREENBUSH, N. Y.

THE POLESCHKO TRANSFORMER.

ALL existing transformers may be classed in two groups; in the one, such as the Ruhmkorff coil, the Gaulard & Gibbs and the Swinburne "hedgehog" transformer, the iron core is in the form of a cylinder; in the other the iron core is in the form of a closed geometrical figure, annular as in the Zipernowski, Deri and Blathy, or otherwise, as in the Westinghouse, Ferranti, &c. In transformers of the first group, the lines of force generated in the iron core by the action of the primary helix are given off as a bundle from the north pole and proceed to the south pole across the outer space, where they form closed curves of all possible radii. The secondary coil in this case is in the intermediate space between the iron core and the exterior system of the lines of force. In transformers of the second group, all the lines of force generated in the iron core by the action of the primary coil remain entirely in the core itself without appearing at the exterior. These lines of force remaining in the iron core can only pass in the interior of the spirals of the secondary coil or they may encircle the outer secondary coil. In both cases the lines of force never touch the secondary helix itself.

In transformers of the first group, as well as the other, the secondary coil is not traversed by all the lines of force which circulate in the iron. It is only a small portion of the lines of force which detach themselves, so to speak, from the general magnetic flow which reaches the secondary coil in closing along short elementary curves.

Recently however, Mr. Arcadius Poleschko, of St. Petersburg, Russia, has devised an arrangement, shown in the accompanying illustrations, by which the magnetic

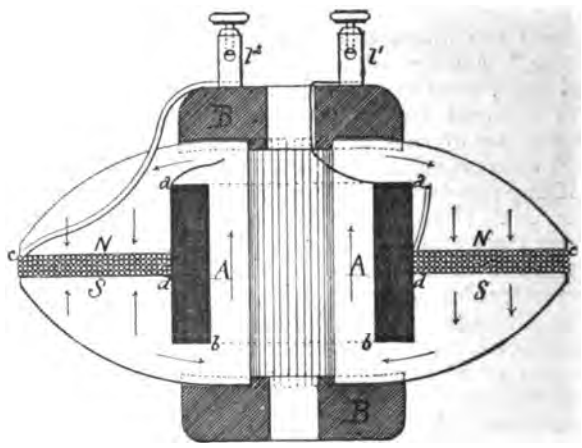


FIG. 1.—THE POLESCHKO TRANSFORMER.

flux in the iron is all made to pass entirely across the secondary coil. In this apparatus the secondary helix $\pm l_2$ $\mp l_2$ is influenced in the first place by the current in the primary helix $\pm l_1$ $\mp l_1$, and in addition by the whole of the magnetic flux which is developed in the iron core A A by the action of the primary coil upon this core.

The core consists of blades or thin plates of sheet iron. The plates A A, the shape of which is shown in Fig. 1, are arranged in the form of a ring and inserted at the top and bottom into two insulating hubs B B. The primary coil $\pm l_1$ $\mp l_1$ is arranged in the vertical cavity *ab* within the interior of the core, Fig. 1, and the secondary coil $\pm l_2$ $\mp l_2$ is arranged outside the first in the form of a flat ring of small height, but of great breadth, in the direction of the diameter of the ring. The secondary coil of this shape is placed in a narrow channel *cd* in the core, extending substantially at right angles to the slot *ab*. The ends of the two coils are led to corresponding terminals on the insulating hub.

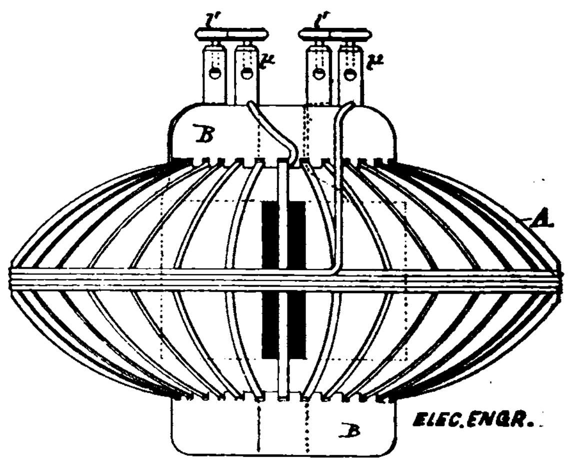


FIG. 2.—THE POLESCHKO TRANSFORMER.

The channel which cuts the mass of the core across the direction of the lines of magnetic force increases very considerably the rapidity of demagnetization and diminishes the hysteresis. The thin iron plates of the core are insulated one from another by air. This arrangement of core has the double advantage of avoiding Foucault currents and of increasing the cooling surface.

THE ELECTRICAL USES OF EUREKA TEMPERED COPPER.

Among the numerous improvements in detail which have aided in raising the electrical arts to their present high standard, those relating to the manipulation of cop-

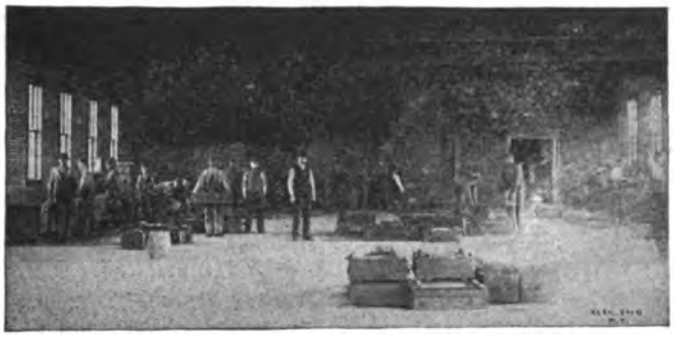


Fig. 1.—Moulding Room, Eureka Tempered Copper Co.'s Factory, North East, Pa.

per itself may well claim a prominent position. As copper in its various forms constitutes a vital material of all electrical apparatus, and especially that of dynamo-electric machinery, a process by which its life could be prolonged was, therefore, a problem, the solution of which might well occupy the time of investigators. It was already known that copper had been tempered by the ancients, as borne witness to by specimens of copper edge-tools in many museums; but the tempering of copper was a lost art, until within a few years, when Mr. Almer Thomas discovered the process as the result of a prolonged attempt to overcome a seemingly insurmountable difficulty. The history of the discovery is well worth recording here. It would seem that trouble with a wrist-pin box in the oil regions of Pennsylvania, while drilling an oil well, led

Fig. 2.—"Gate" Room.

him to experiment with all the remedies and mixtures of metal, and, finding none that would keep cool where he had to use the box, he tried copper, but with no better results. He then, with true Yankee grit, determined to try a scheme of making the box do the work and, after days of patient labor, he succeeded.

From this successful start many annoying wrist-pins in all the surrounding country were repaired and engineers felt that their days of trouble were fast disappearing. Mr. Thomas had in effect discovered, first, a method of casting pure copper without alloys of any kind and free from blow-holes; and, second, a method by which the copper so cast could be hardened sufficiently for all mechanical uses and imparted a strength equal to that of ordinary steel, or, if desired, made as malleable as wrought-iron and capable of being welded or forged into any desired shape by any blacksmith.

The marvelous success met with at once enlisted the attention of capitalists, and the Hon. W. L. Scott and Messrs. Alfred Short and Luzern Merket were associated with Mr. Thomas in the advancement of the new art. This resulted in the formation of the Eureka Tempered Copper Co.

Mr. Alfred Short, who has been a conspicuous figure in all enterprises of a mechanical nature in North East, Pa., was made president and general manager of the company, and in less than two years the company was enabled to construct a building devoted entirely to its own uses. This building is constructed of brick with slate roof, a model in design, furnishing free ventilation, and the moulding-room, shown in the engraving, Fig. 1, is 150 feet by 50 feet and 16 feet in the clear, being probably without ex-

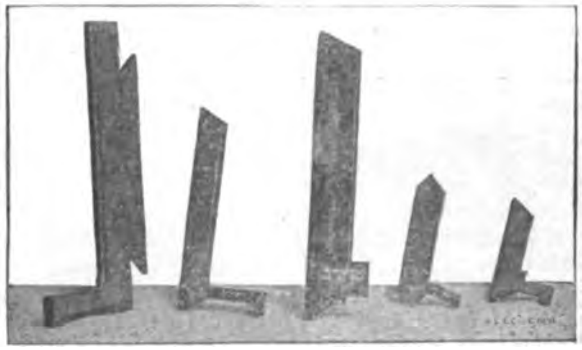


Fig. 3.—Various Forms of Commutator Segments.

ception the largest copper foundry in the world. It is designed to accommodate 12 massive copper furnaces.

The gate-room, Fig. 2, adjoins the moulding-room, where are located many workmen cutting off gates and grinding the surplus from castings. The gate-room was formerly the old moulding-room and is 50 feet by 50 feet.

With a material of this character at their command, and knowing the difficulties encountered with commutators and brushes, it is not to be wondered at that the company devoted the first eighteen months of their existence entirely to the manufacture of commutator segments and brushes.

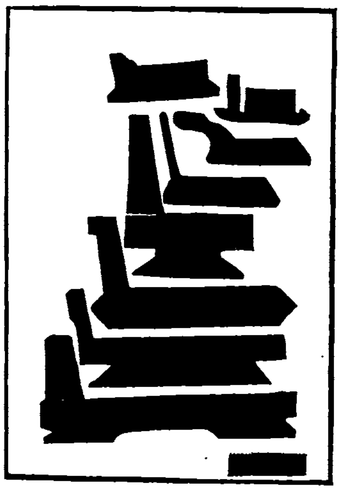


Fig. 4.—Various Forms of Commutator Segments.

For, in spite of the many attempts which have been made to supersede the employment of copper subjected to wear in electrical apparatus, the fact remains that at the present time, no substitute is available which can be said to compare with copper for such purposes. This quest for a substitute was early inaugurated in the present electrical era, and as a result we may note the employment at various times of commutator bars of brass and various alloys, and, in one instance even, of iron, but they all lack the essential qualities of conductivity and toughness which copper alone possesses, and which is brought out in a marked degree in the tempered copper manufactured by the Eureka Tempered Copper Company. This metal combines those peculiar qualities which enable the commutator bar to withstand the peculiar action to which all surfaces transmitting heavy electric currents are subjected. This quality, once pointed out, was quickly appreciated by the manufacturers of electrical apparatus with the result that at present scarcely a single part of electrical machinery subject to rubbing contact and wear is now employed in which the Eureka tempered copper is not in use. Thus, in the accompanying engraving Fig. 3, are illustrated a variety of commutator segments employed in various types of machines which in themselves form an interesting study of methods of construction of this particular and important part of all direct current dynamos. Still other forms of commutator

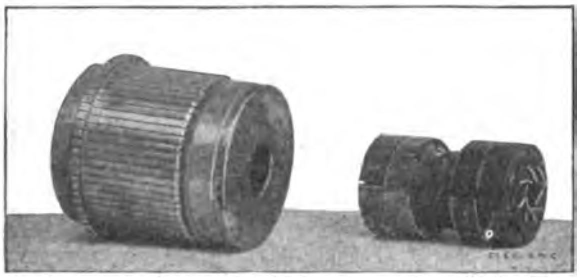


FIG. 5.—LOW AND HIGH POTENTIAL COMMUTATOR.

segments are shown in Fig. 4, each having its peculiar individuality. Fig. 5 shows two well-known types of commutators, that to the left being the usual type employed with the Gramme and Siemens type of armature; and that to the right, a Brush commutator.

But there are still other important surfaces subject to wear on the dynamo, namely, the brushes, and in this direction, also, the Eureka Company has applied its metal with eminent success. Fig. 6 shows the various types of brushes, from those with fine slits up to the type embodying almost a solid construction, adapted to various types of machines. These brushes partake of the same nature as the commutator segments in their wearing qualities, in toughness, as well as in their conductivity, and, as a con-

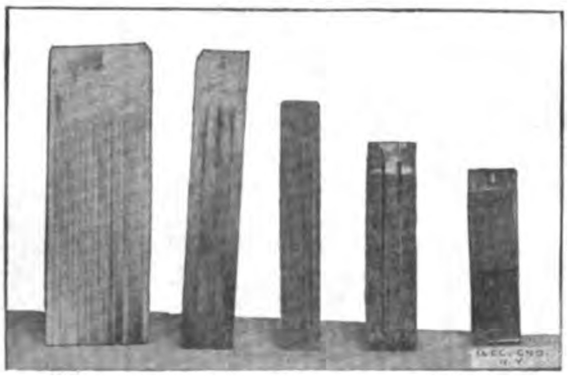


FIG. 6.—TYPES OF TEMPERED COPPER BRUSHES.

sequence, where both are used the sparking at the commutator is reduced to a minimum.

The large wear met with in some of the practical details of electric railway work has also developed several important applications for tempered copper there. Among these we may mention its employment in the gears employed to transmit the power from the motor to the car axle, and also for trolley wheels to take the current from the overhead wire, examples of which are shown in Fig. 7. In the case of the gear wheel, its peculiar toughness gives it not only a long life, but the anomalous structure of tempered copper largely reduces the noise, which is so noticeable and disagreeable a feature in steel pinions. In the case of

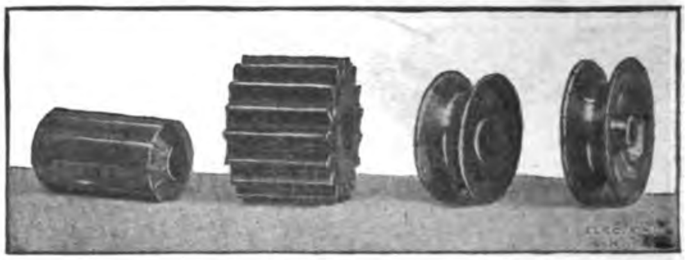


FIG. 7.—RAILWAY GEARS AND TROLLEY WHEELS, TEMPERED COPPER.

the Eureka tempered copper trolley wheels, its wearing qualities have also largely reduced the difficulties encountered by this necessary adjunct to electric railway work. That important *vade mecum* of the electrical worker, the soldering iron, has also brought out the admirable qualities of tempered copper, and our illustration, Fig. 8, shows two forms of such soldering irons, which are very little liable to "burn." This illustration also shows a segment of a Thomson-Houston commutator, for which this copper has been largely employed.

Numerous tests have shown tempered copper to consist

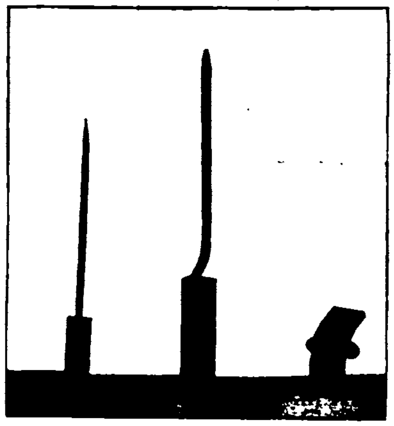


FIG. 8.—TEMPERED COPPER SOLDERING TOOLS.

of copper 99.981 per cent. pure, with a tensile strength of 64,000 lbs. per square inch and a compression strength of 189,000 lbs. to the square inch. A test made a short while ago by the Austrian Government Industrial Department at Vienna, showed a higher tensile strength than many of the steels which had been tested there.

Wire made from tempered copper is being largely used for all purposes where great strength is desired, and its purity renders its conductivity far greater than copper alloys. Besides this, its fibrous nature makes it an excellent metal for bearings, to which purpose it is now being largely applied.

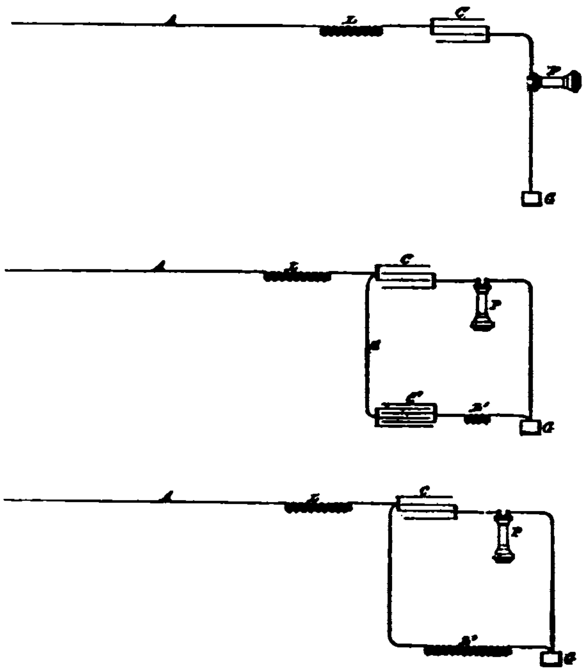
We may note here also that in recognition of the remarkable and valuable properties of Eureka tempered copper, the company has been awarded the John Scott Medal of the Franklin Institute.

Besides the shops illustrated, the works of the company embrace a large store and packing room. The products here assembled include everything made of copper, from the smallest contact buttons or spiral springs, to bearings weighing half a ton each. The machine shop and pattern-room are also extensive and all buildings are equipped with machinery of most modern construction and latest improvement.

The situation on the line of the Lake Shore Railroad, and the New York, Chicago and St. Louis Railroad, with branch tracks running into the works, gives them unexcelled shipping facilities. Each department of the immense works is under the direct charge of a foreman of thorough training and experience, and only skilled workmen find employment in the works. With these advantages the company are enabled to produce the best quality of work, which is attested by the fact that there is scarcely an electrical manufacturing concern in the country that does not use tempered copper in one form or another. The growth and success of this important enterprise is a most striking instance of the manner in which electricity stimulates work in other fields; and the subject has seemed to us specially worthy of extended treatment in our columns.

STANLEY AND KELLY'S INDUCTION PREVENTER FOR TELEPHONE LINES.

It is a well-known fact that the self-induction and capacity of an electric circuit over which a current of a given periodicity is flowing may be adjusted relatively to



Figs. 1, 2 and 3.—Stanley & Kelly's Telephone Induction Killer.

each other and to the current so that only the dead resistance of the circuit will be opposed to the passage of such current. In general, if n be used to denote the number of complete waves of the current per second, L, the coefficient of self-induction of the circuit, and M, its capacity in microfarads, then any line that possesses the necessary values of L and M in the equation

$$n = \frac{10^3}{2\pi\sqrt{LM}}$$

will offer no other opposition to a current of n waves than that of ohmic resistance. It is obvious, however, that for all other frequencies an opposition other than that of ohmic resistance will appear, for higher frequencies, due to an unbalanced self-induction, for lower, to an unbalanced capacity. It is clear, moreover, that as the capacity introduced continues to neutralize the self-induction to some extent for all frequencies, that all rates above the normal will get through more readily than if no capacity were present, although the farther they are from the normal the less will they be helped. It is otherwise with lower frequencies. Here the opposition is due to the capacity, the new element introduced into the circuit, and for rates a certain amount below the normal, the opposition offered by the unbalanced condenser is greater than that previously afforded by the self-induction alone.

In applying this principle to preventing interference due to induction on telephone circuits, Messrs. William Stanley, Jr., of Pittsfield, Mass., and John F. Kelly, of this city, have recently devised the method illustrated in the accompanying engravings. In Fig. 1, A is a telephone line grounded at G, and P a receiver. In order to oppose disturbing currents, a self-induction coil L and a condenser, C are introduced into the circuit between the receiver and the line.

The relative values of these devices are readily adjusted by varying the length of the coil and the size of the condenser, so as to hinder to a very great extent the propagation of waves of a frequency below a predetermined limit, while favoring those producing speech.

In Fig. 2 this arrangement is modified by the addition of a shunt S from line to ground around the condenser and the receiver, which is so adjusted as to capacity and self-induction by means of a condenser C′ of comparatively large capacity and a self-induction coil L of comparatively low self-induction so as to possess a high degree of receptivity for long waves. In Fig. 3 is shown a similar arrangement, except that the shunt S is arranged to have a high self-induction and low resistance, which would tend to shunt the long waves and oppose the short.

ELECTROMOTIVE FORCE, WITH SPECIAL REFERENCE TO THE EXTENSION OF OHM'S LAW.—I.

BY

Maurice Oudin, M.S.

A celebrated physicist has said that science alone has the claim to be called such, whose laws can be expressed by mathematical relations. Such are the sciences of mechanics, heat, light, sound, electricity and magnetism; in fact, all the physical sciences save chemistry, and even the last is approaching that state where it will be included in the list. Actual measurement, involving the application of numerics is the only means we possess of verifying mathematical laws. Newton was ready to abandon his grand hypothesis of the law of universal gravitation, because an error was made in measuring a degree upon which he had based his computations. The idea of potential long remained a mathematical abstraction. It was only when applied by Green to the calculation of electrical forces that its true use and significance were recognized. The truth of the mathematical statement that the inside of a hollow sphere is free from electrification was not verified until Michael Faraday built his experimental cage. Without the ability to express the proper relations of facts and to interpret those relations, our knowledge can at the most be meagre and uncertain.

The simplest and best-known law in electrical science is that enunciated by George Simon Ohm. The result of his mathematical speculations on the transmission of electricity through a conductor was first published in Poggendorf's Annalen in 1825. The essay afterwards appeared in book form in 1827, and was translated into English by Dr. Francis in the year 1841. It has been a matter of frequent comment that the great men of Germany have not always received due recognition and in many cases have gained their reputation late in life. It is difficult for us to understand the marked disapproval and even bitterness with which Ohms' work was received. His theory was utterly discredited and then ignored. Indeed Faraday was unfamiliar with the law of Ohm, and Henry likewise was ignorant of its existence although in dealing with electric currents he had intuitively recognized the principles involved. Two decades ago the vague terms intensity and quantity, were the usual means of indicating currents of high and low electromotive force.

This same uncertainty was attached to the phenomena of electrical science generally. There was no system of absolute measurement in general use until after the exhaustive work of the British Association on electrical standards, nearly 30 years ago. And this notwithstanding that the theory of electricity had almost reached its present state of development. Henry took the intensity of the shock experienced from a current of electricity as an indication of its strength, and earlier in the history of the science the distance to which a pith ball was repelled and the jumping distance in air of a spark were also means of indicating magnitude of electrical phenomena. Even after the general introduction of standard instruments into our lecture-rooms the greatest ignorance regarding their constants prevailed for a long time.

The application of Ohm's law helped to bring order out of this chaotic uncertainty. Only the necessities of practice, however, caused it to be dragged out of the waste heap. The successful application of its principles in telegraphy called the attention of scientific men to this law, the simplest in electrical science and of an importance the most truly immense.

Of the three fundamental quantities of a galvanic circuit, electromotive force is the most important. That quality called resistance is entirely dependent upon the specific nature of the substance of which the conductor is composed. A current is the result of an E. M. F. acting at the time or previously. Electricity in the sense of quantity of electrical separation has invariably associated with it an E. M. F., just as heat involves the idea of temperature or a suspended weight that of gravity. An E. M. F. can exist without the presence of the other two constants. The terminals of a voltaic cell and of an open coil moving near a magnet offer examples of the presence of an E. M. F. unaccompanied by a continuous current. It is not within the scope of this paper to view the practical side of the subject, nor to indicate the relation of the galvanic quantities to other electrical quantities. I shall confine myself to an exposition of the sources and manifestations of electricity in motion, dwelling more particularly upon the theory of E. M. F. as it is the chief factor in the modification of Ohm's law.

When a Leyden jar is discharged through a circuit, or a current from any source is maintained in a wire we say there is a transfer of electricity from a point at a certain potential to one at a lower potential. The property of producing this difference of potential in virtue of which electricity is set in motion, is ascribed to a cause called electromotive force. It is not a force at all as we understand the meaning of force as used in mechanics. The word is here used by analogy only; there is no identity whatever. Just as a force must be applied to lift a weight a certain height (a point of higher potential with respect to its original position), so by analogy, when there occurs an electrical separation, as at the electrodes of a battery, we call that producing it an E. M. F. In the mechanical illustration, if the support be removed the weight will fall to a gravitational plane of lower potential. Join the terminals of the battery and a current will flow from the positive or point of higher potential, to the negative or point of lower potential.

It is important that the distinction between E. M. F. and difference of potential should be clearly made, as there exists much confusion with regard to the proper use of these terms. In a circuit in which a source of E. M. F. is localized, there is between any two points a difference of potential. The line integral of the fall of potential measures the E. M. F. There can be no D. P. without a previous E. M. F., but we may have the latter without the former. As for instance when a cylindrical magnet is suddenly introduced into a coil of wire. An E. M. F. is set up in the wire, yet every point in the circuit is at the same potential. The same is true when an annular vessel filled with water is made to rotate in its plane. A motion of the liquid ensues although there is no difference of level. Analogies are useful, and to further illustrate my point, conceive a pump raising water to a height, say, of 20 feet. Here in a crude way the force actuating the pump corresponds to E. M. F., and the new elevation of the water with respect to its original level to D. P. Remove the E. M. F. and in consequence of the D. P. a current flows. In short, we may say, E. M. F. produces a D. P., and is measured by it.

The relation of E. M. F. and energy is a close one, indeed E. M. F. may be said to be absolutely inseparable from the idea of energy. Although, as we have seen, an E. M. F. may exist without an actual flow of electricity it requires for its excitation an expenditure of energy, and produces what we may call an electrical displacement. The work done in the deflection of an electrometer needle, under the influence of electrostatic forces against the torsion of a wire, proves this by Joule's famous principle of the conservation of energy. The amount of work involved is necessarily small. It would require instruments of great precision and refinement to determine the difference of work required to suddenly insert a magnet and a soft iron bar into an open circuited coil. The moment the circuit is closed, however, and the magnet thrust in, a current flows and then the force necessary for the operation is considerable. In electrostatics, difference of potential is measured by work done. Two pith balls of opposite and equal charges cannot be separated without a change in the energy of the system, the amount of which is represented by the equation—

$$\text{Energy} = m\left(\frac{1}{r} - \frac{1}{R}\right)$$

where m is the total electrification or quantity of electricity, and r and R are the original and final distances separating the pith balls. In its final state the energy of the above system is at a maximum and wholly potential. If left to itself it speedily falls to a minimum, the potential energy becoming kinetic in the process.

The change from one condition to the other always manifests the presence of a force. It is only when a change of energy of one form into another occurs or tends to occur that we are aware of the existence of an E. M. F. In the case of the pith balls it will be observed that there is a transfer of electricity against the attracting forces. The work done on the system is $M. V$, the product of the quantity of electricity into the difference of potential. Such a transfer of electricity is analogous to a current; it is identical in its effects, as Prof. Rowland and others have shown, when the transfer is made with the velocity of light, which is the rate of transmission of an electric impulse along a conductor. All generators of electricity are transformers of energy, the dynamo transforms energy of mechanical motion into electrical energy, the battery that of chemical affinity, and the thermopile that of heat into electrical energy. The resulting current is a manifestation of some kind of motion. It is evidence of a transfer of energy. The E. M. F. at the terminals of a generator is a measure of the urging or tendency of the generator to transform mechanical, chemical or heat energy into electrical energy. The product of these two quantities, current and E. M. F. gives the total energy or activity of the circuit.

There are two ways of viewing the manner in which an E. M. F. gives rise to a current. We may regard the E. M. F. as a force applied, either at the ends of the conductor, like the pressure of a pump drawing water through a pipe, or literally throughout the whole extent of the conductor like the vanes of a paddle-wheel. The outcome of recent experiments seem to show that the last view is the correct one. Oersted's discovery of the disturbing influence upon a compass needle by a current, as shown by Faraday, indicated the existence of a medium that transmitted electrical stresses. The mathematical treatment was undertaken by Maxwell. The results were found to be in strict accordance with Faraday's experiments. It remained for Hertz of Bonn to prove, as far as experiment can prove, the existence of a medium, and to confirm Maxwell's theory that the medium in which electrical stresses are propagated is identical with the light-transmitting medium—the ether. It is here we must abandon hydrostatic analogy, for there is no external disturbance to indicate a flow of water through a pipe. Conducting bodies are regarded as breaks in the ether, offering an easy passage to a flow of electricity. The battery, dynamo, or other generator is conceived as placing the surrounding medium under a strain. The stress thus produced is propagated along the line of least resistance, viz., the conductor, and in consequence there follows that action called electrical current. The medium plays the principal role, the function of the conductor being to determine the direction in the medium in which the transfer of electrical energy shall take place.

To Galvani is due the discovery of a new electrical manifestation; but the scientific mind of Volta developed the immense possibilities of an uncertain phenomenon. With the invention of the voltaic cell that branch of electrical science which deals with the phenomena of current flow had its beginning. For over half a century the voltaic cell was the only means of evoking large currents of electricity. Although for almost all practical purposes it has been replaced by the dynamo, its great historic interest, and especially the uncertainty attached to the theory of its action, claim for it a prominent place. In Volta's time the question as to the seat of the E. M. F. in the battery arose, and the dispute has been kept up with intermittent vigor ever since. The two great theories are the contact and the chemical. The advocates of the former claim that E. M. F. of the cell is due to the mere contact of dissimilar substances. The holders of the chemical theory formerly denied the existence of an E. M. F. not due in some way to chemical action.

Some authorities now advance a theory which is in the nature of a compromise. If a piece of copper and a piece of zinc be brought in contact, there is found to be an E. M. F. acting across the junction. If these be joined at their free ends by a substance having a chemical affinity for either metal a current is developed and maintained constant as the result of the chemical action, and at the expense of one of the metals. In other words, contact produces E. M. F. which on closed circuit gives rise to a current when some extraneous means are supplied to keep the E. M F. constantly renewed.

Sir Humphrey Davy was the first to attempt to reconcile the two theories. Faraday noticed that the composition of the electrolyte was always altered by the passage of a current, and so attributed the flow to chemical action. Sir William Thomson brought out a paper in 1851 demonstrating the existence of an E. M. F. at a junction of two metals from the well-known phenomenon called after its first observer, the Peltier effect. By far the most elaborate experimental work in this subject was carried out by Professors Aryton and Perry in Japan. They established beyond a doubt the law that the total E. M. F. of a circuit may be reckoned by adding up the E. M. F. observed for every pair of substances in contact.

"LIKE UNTO LIKE."

The editor of one of the leading technical journals of this city, in forwarding a subscription for a friend, says: "This is a Christmas present of a mighty nice electrical journal to a mighty smart young electrician."

"MASSAGE" WITH CURRENTS OF HIGH FREQUENCY.

BY

Nikola Tesla

I TRUST that the present brief communication will not be interpreted by the readers of THE ELECTRICAL ENGINEER as an effort on my part to put myself on record as a "patent medicine" man, for a serious worker cannot despise anything more than the misuse and abuse of electricity which we have frequent occasion to witness. My remarks are elicited by the lively interest which prominent medical practitioners evince at every real advance in electrical investigation. The progress in recent years has been so great that every electrican and electrical engineer is confident that electricity will become the means of accomplishing many things that have been heretofore, with our existing knowledge, deemed impossible. No wonder then that progressive physicians also should expect to find in it a powerful tool and help in new curative processes. Since I had the honor to bring before the American Institute of Electrical Engineers some results in utilizing alternating currents of high tension, I have received many letters from noted physicians inquiring as to the physical effects of such currents of high frequency. It may be remembered that I then demonstrated that a body perfectly well insulated in air can be heated by simply connecting it with a source of rapidly alternating high potential. The heating in this case is due in all probability to the bombardment of the body by air, or possibly by some other medium, which is molecular or atomic in construction, and the presence of which has so far escaped our analysis—for according to my ideas, the true ether radiation with such frequencies as even a few millions per second must be very small. This body may be a good conductor or it may be a very poor conductor of electricity with little change in the result. The human body is, in such a case, a fine conductor, and if a person insulated in a room, or no matter where, is brought into contact with such a source of rapidly alternating high potential, the skin is heated by bombardment. It is a mere question of the dimensions and character of the apparatus to produce any degree of heating desired.

It has occurred to me whether, with such apparatus properly prepared, it would not be possible for a skilled physician, to find in it a means for the effective treatment of various types of disease. The heating will, of course, be superficial, that is, on the skin, and would result, whether the person operated on were in bed or walking around a room, whether dressed in thick clothes or whether reduced to nakedness. In fact, to put it broadly, it is conceivable that a person entirely nude at the North Pole might keep himself comfortably warm in this manner.

Without vouching for all the results, which must of course, be determined by experience and observation, I can at least warrant the fact that heating would occur by the use of this method of subjecting the human body to bombardment by alternating currents of high potential and frequency such as I have long worked with. It is only reasonable to expect that some of the novel effects will be wholly different from those obtainable with the old familiar therapeutic methods generally used. Whether they would all be beneficial or not remains to be proved.

"HOW TO MAKE INVENTIONS."

MR. E. P. THOMPSON is receiving many encomiums on his book just issued with the above title. The *Boston Transcript* says it is "almost literally worth its weight in gold." The *American Machinist* says that it is "invaluable to those who wish to make invention a business and provi le themselves with means of preparation."

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XII. NEW YORK, DECEMBER 23, 1891. No. 190.

"Make-and-break"—means "make" for the man who sells that invention and "break" for the man who buys it.—Dr. Elisha Gray.

POLYPHASAL CURRENTS.

NOTWITHSTANDING the widespread attention which alternate-current motor and generator work has attracted during the last few years, the subject appears to be one which is but faintly grasped by the majority of electricians, judging from the lack of knowledge of essential principles displayed. It is therefore a subject for congratulation that there is now available a discussion of the nature of polyphasal currents, which will enable those not already familiar with the subject to obtain an excellent insight into their true nature and effects. In the course of his paper, read before the American Institute of Electrical Engineers, Dr. Pupin takes occasion to dwell at some length on the claims made by Dobrowolsky in Germany as to the superiority of his apparatus over that of Tesla, Bradley and others, in that there is no fluctuation in the strength of the field in his motors. Dr. Pupin well shows the untenable position taken by Dobrowolsky by proving the very slight difference which exists between two and three-phase types of motors in this respect. But, for those who have given close attention to the work of Mr. Tesla, this question would appear to have been settled long ago. A perusal of Mr. Tesla's work will show that he dwelt on these very points in his original paper read before the American Institute of Electrical Engineers in May, 1888, and from which we quote as follows:

> The inductive effect exerted upon the secondary coils will be mainly due to the shifting or movement of the magnetic action; but there may also be currents set up in the circuits in consequence of the variations in the intensity of the poles. However, by properly designing the generator and determining the magnetizing effect of the primary coils, the latter element may be made to disappear. The intensity of the poles being maintained constant, the action of the apparatus will be perfect, and the same result will be secured as though the shifting were effected by means of a commutator with an infinite number of bars.

This shows that for the uniform shifting no more than two phases are required, and that it is only necessary to design the generator properly in order to obtain the desired result. Dr. Pupin refers to this also in his paper, where he points out toward the end that "nearly constant rotary magnetic fields can be produced in practice by a small number of phases, probably not more than three, by properly shaping the curve of the impressed E. M. F." It may not be out of place to remark here that Mr. Tesla in his original patents has also shown multiphase generators and motors, and dwelt on these points even more directly than he did in the paper read before the Institute in 1888, and we may also quote from that paper the following significant remark:

> In transformers and in a certain class of motors the fluctuation of the poles is not of great importance, but in another class of these motors it is desirable to obtain the theoretical result.

This statement applies to the two types of motors shown by him, namely, synchronizing and torque motors respectively. Dr. Pupin correctly points out the impossibility of telling from the number of phases the amount of the fluctuation. With two or with three phases only, practically the same result is obtained as though there were an infinite number of phases, but we think that, inasmuch as a motor should in most cases possess a certain tendency to synchronism, practice will show the inadvisability of employing too great a number of phases, as in such a case the falling off in speed would result in a diminished output per weight and would disqualify the motor for many purposes. As regards polyphasal generators, it seems to us, as Dr. Pupin puts it, that a high number of phases is impracticable and their employment hardly warranted in the light of the above statements, it being evident that two or three phases are quite equal to accomplishing the desired results.

The paper read by Dr. Pupin also serves to call attention to some curious analogies between polyphasal and continuous-current generators and as such they must necessarily impart to the former qualities which have heretofore not been deemed to be inherent in them. We can only express again our gratification at the work of Dr. Pupin and re-echo the sentiment of Prof. Elihu Thomson, who presided, that the paper contains the only clear exposition published thus far of the principles which underlie the polyphasal-current systems. It is understood that Dr. Pupin will give a brief series of papers—two or three—before the Institute on this subject. With the principles thus clearly pointed out and with the advantages to be derived from the use of condensers in connection with alternate current apparatus, especially motors, the time can not be far distant when the latter will have become as familiar an object as the continuous current motor is to-day.

"KNOCKING OUT" THE BERLINER PATENT.

THE picturesque misinformation that cultivated Englishmen possess about this country is strikingly exemplified in an able editorial on "the Microphone in America," appearing in the December 4 issue of the London *Electrician*. Its view of the granting of the Berliner patent is thus expressed: "It is as if one had appropriated a wrong umbrella and after wearing it out taken it back again, getting a new one in its place. You cannot do that in polite society; *but you can in the New York Patent Office*." Our contemporary adds that "there is talk of invoking *the aid of the Legislature* to put an end to collusive and injurious "interferences.' It is a pity that our contemporary, who is usually so well informed and so sound in judgment, should be under the impression that the "New York Patent Office" allows this sort of thing, or that the matter is subject to the tender mercies of our State Legislature. It is the Chicago Board of Trade that is responsible in such cases, and these collusive interferences can only be put an end to by the "referendum" in the District of Columbia, or by a constitutional ballot in the thirteen original States of the Union. No doubt this is a roundabout way of correcting an abuse, but it has been carefully modeled after the precedent which requires that the Parliament of the British Empire shall sit in judgment on the wish of Puddlecombe-by-the-Haystack to have a street railway.

TRANSFORMERS WITH OPEN MAGNETIC CIRCUIT.

The designs which have been adopted in transformer work may be said to have kept very close to those of the dynamo in so far as the nature of the magnetic circuit is concerned, and this is probably a direct outcome of the modern conception of the magnetic circuit and its treatment analogously to the electric circuit. The reduction in magnetic reluctance effected in transformers with closed iron cores, over the older forms embodying open magnetic circuits, was immediately followed by increased output at a given frequency and by better regulating qualities. But there are not wanting those who find good qualities in the older types, notably among them being Mr. Swinburne, whose "hedgehog" type of transformer is well known to our readers. The principle advantage claimed by Mr. Swinburne is increased efficiency at light loads as compared with the closed circuit type. With the evident object of retaining this benefit, while at the same time avoiding the loss of magnetic lines met with in the straight core, Mr. Poleschko has designed the type of transformer illustrated on another page. While there has been considerable discussion on the relative merits of these two types of transformers, we still lack the authoritative figures of an impartial comparative test, and we suggest this as a subject of research.

ANNUNCIATOR AND BELL WORK.

THOUGH probably among the oldest of the applications embodying electrical signaling devices, the methods of construction and installation in annunciator and bell work have probably undergone very few changes from those practiced twenty years ago, and "electrical bell hanger" has indeed become a term of reproach in the profession. That this term, however, does not necessarily imply an utter lack of knowledge of electrical principles or of proper appreciation of the value of good work is well brought out in the interesting paper of Mr. Charles G. Armstrong on "Improvements in Annunciator and Bell Work," read before the Brotherhood of Electrical Mechanics in Chicago. Mr. Armstrong urges in the first place the discarding, as far as possible, of the large number of batteries frequently scattered about in large buildings feeding different bell circuits, and their replacement by a properly designed dynamo-generator. He also points out the necessity of employing a better quality of wire than that represented by the venerable annunciator wire, and he prefers weather-proof for this purpose. He also advocates the use of interior conduits, and, in general, the collection of all electrical signaling apparatus at one central point and its supervision by a competent attendant. Mr. Armstrong's paper is one of the best and most practical that we have seen for a long time.

"Catch-as-Catch-Can" Executions.

AN official report has now been made by Drs. McDonald and Ward on the Loppy execution, from which it appears it took ten minutes to prove to that unfortunate villain that death by electricity is instantaneous. As the *New York Times*, in an admirable article on the subject remarks: "The man was killed by sections, at odd jobs, in an off-and-on sort of fashion, 15 seconds at a time. They began to kill him at 11:54:36; at 12:05, ten minutes and 24 seconds later, they discovered 'the fact that death had occurred.' They declare furthermore that death was apparently instantaneous and painless. * * * If death was really instantaneous, it must have occurred at the first contact, and the other three were superfluous and revolting." We are glad to see the *Times* and other decent papers coming to the conclusion that this electrical execution must stop.

A Shower Bath of Currents.

The attention of medical men is likely to be arrested by the suggestive little note in our issue this week from Mr. Nikola Tesla, on some peculiar phenomena associated with the effect of rapidly alternating currents of high potential on the human body. As Mr. Tesla points out, the surface of the body can thus be heated under almost any conditions; and it would obviously be easy to direct or concentrate this effect upon any part needing treatment, and this whether the patient be even lying in bed unable to stir hand or foot. The medical profession has so intelligent an interest in the therapeutic use of electricity that we believe it will soon find employment for this novel method of application. It is curious how many side issues a new line of investigation opens up.

Transformer Calculations.

IN this issue Mr. Charles Steinmetz concludes his series of articles on the Elementary Theory of the Alternating Current Transformer. The graphical study of mathematical problems largely facilitates their conception in giving to the values their relative dimensions in a tangible form, such as figures alone do not convey. As such, the work of Mr. Steinmetz will prove an interesting treatise and the results of his tests on existing apparatus bear out well the accuracy of the assumptions made by him and upon which his calculations were based.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—XX.

(*Concluded.*)

BY

Chas. Steinmetz.

The secondary circuit is not free from self-induction either, and the secondary current C_1 must lag behind the secondary E. M. F., E_1 by an angle ω_1. The constants of the transformer were:

Cross-section of iron = 63.3 square centimetres.
Length " = 30.8 centimetres.

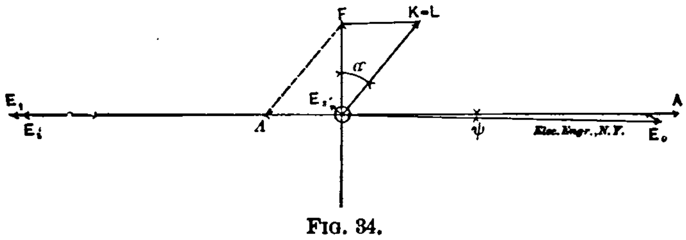


FIG. 34.

Internal resistance of secondary = .04 ohms.
" " " primary = 21.8 ohms.
Number of secondary turns n_1 = 35.
" primary " n = 675.

The electric quantities were found by the tests:

		Primary impressed E. M. F.	Primary current.	Secondary terminal pressure.	Secondary current.	Frequency.	Hysteretic loss.
		E_0	C	E_t	C_1	N	H[1]
1	Full load..........	1020	.634	49.3	10.65	132	69.7
2	Half load....... ...	1036	.383	50.6	5.83	132	83.1
3	$\frac{1}{10}$ load............	1021	.190	51.4	1.26	138	93.9
4	Open circuit.......	1030	.147	53.5	.....	138	95.7

From these we derive the results:

	Drop of potential in secondary.	Secondary induced E. M. F.	Primary resulting E. M. F.	Primary induced E. M. F.	Secondary M. M. F.	Primary M. M. F.	Ideal M. M. F. of hysteresis.
	E_{11}	E_1	E	E_i	L_1	L	$A = \frac{H n_1^{1}}{E_1}$
1	.4	49.7	14	958	373	428	49.1
2	.2	50.8	8	980	204	259	57.2
3	..	51.4	4	991	44	128	63.9
4	..	53.5	3	1030	...	99	62.6

1. These values of hysteretic loss being derived as the difference of primary watts and secondary volt-amperes, must be too small for increasing secondary load, as the real secondary watts are *less* than the volt-amperes, because of the shifting of phase ω_1, caused by the self-induction of the secondary circuit.

From the value of ideal hysteretic M. M. F. for open circuit, $A = 62.6$ ampere turns, we get the angle of magnetic lag, $\sin \alpha = \frac{A}{L} = .6323$. The angle $\alpha = 39°$, and the resulting M. M. F., $F = \sqrt{L^2 - A^2} = 76.7$ ampere turns, while the direct determination of this angle, as the complementary angle to the difference of phase between primary current and secondary E. M. F., gives

$$\sin \alpha = \cos (C\, E_1) \frac{\text{mean } (c\, e_1)}{\sqrt{\text{mean}^2\, c \times \text{mean}^2\, e_1}} = .6514;$$

angle $\alpha = 40°$. The indirect way, by means of the diagram, gave $\alpha = 39°$, which is almost the same, though the wave of current is anything but sinusoidal.

The angle $\alpha = 40°$ gives as the ideal M. M. F. of hysteresis, $A = L \sin \alpha = 63.5$ ampere turns, against 62.6 ampere turns found directly, and the resulting M. M. F., $F = L \cos \alpha = 75.9$ ampere turns, against 76.7 ampere turns, as found before.

It is therefore evident that even in cases where the wave differs widely in shape from the sine form, the polar diagram of transformers represents the phenomenon very fairly.

If the resulting M. M. F., $F = 76$ ampere turns for open circuit, that is for the induction, $E_1 = 53.5$ volts, and the

WESTINGHOUSE 10 LIGHT TRANSFORMER.

Frequency, $N = 132$ complete periods per second. Secondary induced E. M. F., $E_1 = 50$ volts effective.

		Phase of primary current.	Phase of impressed primary E. M. F.	Difference of phase between primary current and impressed E. M. F.	Secondary current.	Primary current.	Secondary M. M. F.	Primary M. M. F.	E. M. F. consumed by secondary internal resistance.	Primary resulting, or heating E. M. F.	E. M. F. of self-induction in primary circuit.	E. M. F. of self-induction in secondary circuit.	Angle of secondary retardation.	Primary impressed E. M. F.
		ϕ	ψ	ω	C_1	C	L_1	L	E_{11}	E	E_s	E_{1s}	ω_1	E_0
1	Full load...	12.5°	—10.5°	23°	10.65	.647	373	437	.4	14	197	2.5	3°	1070
2	Half load...	17°	— 6.5°	23.5°	5.83	.403	204	272	.2	8	123	1.3	1.5°	1050
3	$\frac{1}{10}$ load.....	36°	— 2.5°	38.5°	1.26	.188	44	127	..	4	57	.3	.3°	1040
4	Open sec...	49°	— 1.5°	50.5°	.....	.141	...	95	..	3	43	...	....	1030

Angle of magnetic lag, $\alpha = 41°$.
Impressed M. M. F., $K = 95$ ampere turns.
Resulting M. M. F., $F = 75$ ampere turns.
Ideal M. M. F. of hysteresis, $A = 58$ ampere turns.
Secondary induced E. M. F., $E_1 = 50$ volts effective.
Primary induced E. M. F., $E_i = 964$ volts effective.
Loss of energy by hysteresis, $H = 83$ watts.

frequency, $N = 138$, for full load, that is, for $E_1 = 49.7$ volts, and $N = 132$, we derive,

$$F = 76 \times \frac{49.7}{53.5} \times \frac{138}{132} = 74 \text{ ampere turns}$$

and are now enabled to produce to polar diagram of this transformer, for open circuit and for full load in Figs. 34 and 35.

Fig. 34 gives us the self-induction of the secondary circuit, causing a shifting of phase of secondary current against secondary E. M. F. by an angle : $a_1 = 3°$, and the

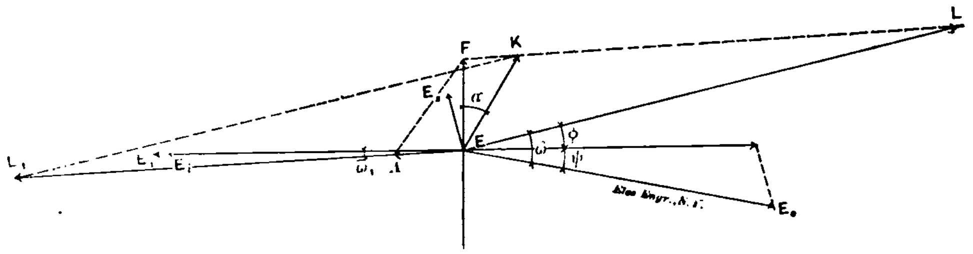


Fig. 35.

ideal hysteretic M. M. F. for full load, $A = 47$, against 49.1, as observed, causing an angle of magnetic lag, $\alpha = 33°$.

The E. M. F. of self-induction is derived from E_0, E, E, it being perpendicular to the current C. Hence,

1. $E_1 = 192$ volts for full load.
2. 116 " " half "
3. 55 " " $\frac{1}{10}$ "
4. 43 " " open circuit.

because it is proportional to the primary current and the frequency.

To compare the diagrams for different loads we reduce the electric quantities to the same magnetization and to the same frequency, by means of the law of the 1.7th power, so far as hysteresis is concerned, and otherwise by direct proportion.

Let the frequency be : $N = 132$, the secondary induced E. M. F.: $E_1 = 50$ volts. Then we derive the values given in the table, and represented in the complete diagram, Fig. 35.

It is especially interesting to notice here that, when reducing the four sets of transformer tests to the same conditions, the steady decrease of hysteretic loss for increasing load, observed by Prof. Ryan on this transformer, 95.7, 93.9, 83.1, and 69.7 watts, disappears, and the four values of hysteretic loss for different loads become 82, 85, 81 and 72 watts. The figure for full load, 72 watts, will be influenced greatly by a slight error of observation in one of the component factors, and this figure is the only one which differs much from the mean value.

Hence, *these tests cannot be used to prove a decrease of hysteretic loss,* but on the contrary, if the last figure be excluded, seem rather to indicate a *constancy and independence of the hysteretic loss from the load,* as is to be expected from theoretical reasons.

A comparison of this Westinghouse transformer with the Ganz & Co. transformer cannot well be made, because the one is a small 1 h. p. and the other a large 10 h. p. transformer, and therefore the larger transformer will give a very much more favorable diagram, as, indeed, Figs. 33 and 36 show.

These diagrams show one thing plainly; that a large transformer is much more efficient, and compounds better than a small one, and that therefore the practice of supplying each house separately by small transformers is inferior to that of supplying a whole district with a large transformer.

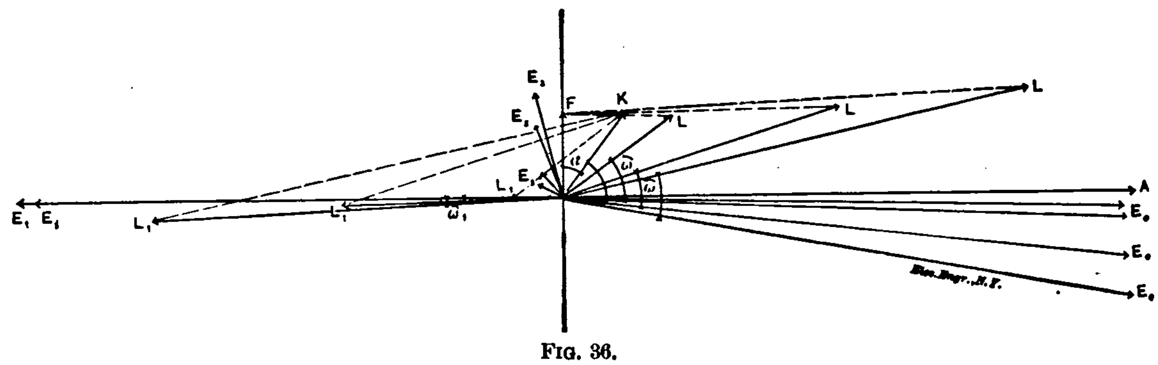


Fig. 36.

ELECTRIC CARS IN PARIS.

The Compagnie des Tramways Nord, says the *Bulletin International,* will shortly inaugurate a new service of cars between the Opera and Saint Denis. The cars will be run by electricity by means of Laurent Cély accumulators supplied by the Société pour le Travail Electrique des Métaux at a price of 4.25 cents per car mile. The route has several severe gradients; between the Rue Faubourg-Montmartre and the Rue Rochechouart the gradient is 5.5 per cent., or one in 18½. The line is nearly four miles in length. The result of this further introduction of storage cars will be watched with great interest.

A NEW THERMO-ELECTRIC BATTERY.

An ingenious little thermo-electric battery has recently been perfected which presents the following features: A small block made of a certain alloy has a small wire or a strip of nickel imbedded in it near each end; the alloy consists of antimony, three parts, and zinc, two parts. The wires project in a vertical direction from the horizontal top face of the block, and the end which is to be heated is protected from fusion by a casing made of iron. To form a battery, a number of these blocks are taken and joined in series, and they are so disposed that their cased ends can be heated to a high temperature without fusing the unprotected portions.

THE ATHENS, GA., ELECTRIC RAILWAY.

The Athens Electric Railway was built by the Equitable Engineering and Construction Co., Drexel Building, Philadelphia, who took the contract for supplying the overhead electrical construction, station electrical apparatus, and electrical car equipments. This road has the McGuire trucks, and the Rae 30 h. p. electric motors. There are five cars in daily service, and five miles of track laid with 40 pound "T" rail. The power plant consists of one 80,000 watt Rae generator, driven by a Ball compound high-speed engine.

This road has been running since the middle of June and not a single cent has been spent for repairs on any part of the apparatus. The entire electrical work was done by Mr. George B. Abele, of the Equitable Co., and is one of the best pieces of electric railway work in the South. Our illustration gives a good idea of the construction and appearance of this typical Southern road. Mr. John T. Voss, manager of the road, wrote the Equitable Co. recently as follows: "The Rae motors and dynamo installed by you on our road have done all you claimed for them and have proved highly satisfactory to us. The cost of repairs is small compared with other systems which we have investigated;

The Athens, Ga., Electric Railway.

the motors make less noise, and there is less necessity for keeping a skilled electrician in our employ than with any other system known to us, owing to the extreme simplicity of the electrical details of the machinery. If at any time you want to refer to us, we will be glad to favor you."

THE MEASUREMENT OF SMALL CURRENTS AND POTENTIAL DIFFERENCES.

The third meeting of the Electrical Department of the Brooklyn Institute for the season was held on Friday evening, Nov. 20, 1891 in the large lecture-room of the Y. M. C. A., President Hamblet in the chair.

After the reading of the minutes of the previous meeting, the president introduced Mr. Edward H. Lyon, who gave a description of a method of measuring very feeble currents and small differences of potential of which we present the following abstract: Mr. Lyon first gave a diagram of the well-known method of La

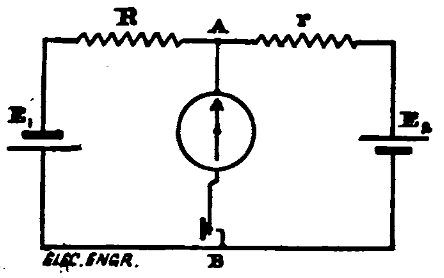


Fig. 1.—La Coine Method.

Coine for comparing the electromotive force of two batteries, as shown in Fig. 1, where the battery to be measured E_2 opposes a standard battery E_1, through the galvanometer bridge A B; R being a fixed resistance of a thousand ohms or more, and r an adjustable resistance, such as a rheostat, which is varied until no deflection is obtained on the galvanometer, when $E_1 : E_2 :: R : r$. The battery resistance need not be considered unless very high.

The Poggendorff method was then shown in Fig. 2. In this method a standard battery and galvanometer are shunted around a known resistance forming part of the circuit in which is placed the battery to be measured, the position of the contact B being varied until a balance is obtained.

Mr. Lyon stated that in the manufacture of instruments for the measurement of the heavy currents and high potentials dealt with in central station practice considerable perfection had been attained, but there was no satisfactory instrument on the market for the measurement of small differences of E. M. F. and current, which was portable and at the same time sensitive and accurate.

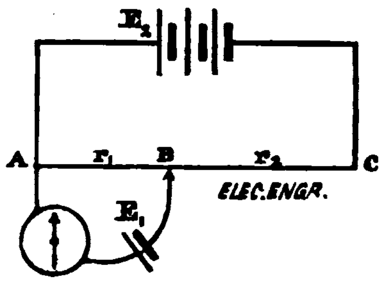


Fig. 2.—Poggendorff Method.

The instrument described by Mr. Lyon possessed both of these qualifications, and consisted of the combination of the La Coine and Poggendorff methods with a Wheatstone bridge, galvanometer and small cell of dry battery, the whole being placed in a compact carrying case.

If it were necessary to measure a battery having an E. M. F. of 1.002 volt or current of .041 ampere, this method insured the accuracy of the third place of decimals. It was not generally known that a dry battery which was worthless for many commercial purposes made an excellent standard cell if closed for short intervals only through a thousand ohms or more, and its E. M. F. would not change appreciably for a long time. He had found Dr. Gassner's very constant for this purpose, although others might be equally good. A small dry cell kept in a warm closet and used occasionally, had only lost .01 volt, since June 6th last.

An illustration of this method was then given. Fig. 3 shows an ordinary Wheatstone bridge with infinity plug removed and a

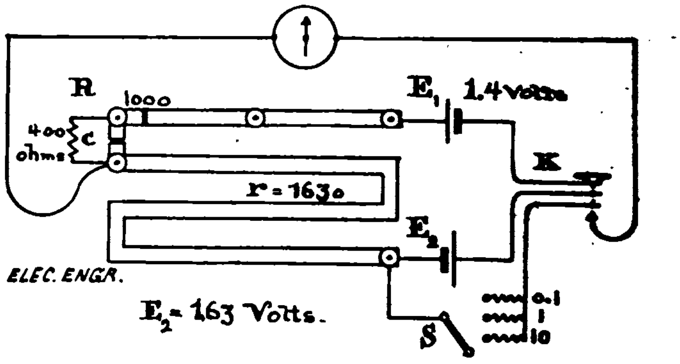


Fig. 3.—Lyon Method.

compensating resistance coil inserted to insure direct readings. This coil may be adjusted to any change that occurs in the E. M. F. of the standard cell—1,000 ohms is unplugged in one of the arms of the bridge. This with the compensating coil, brought the fixed resistance R up to 1,400 ohms, as the standard cell was known to have an E. M. F. of 1.4 volt. It was found necessary to unplug 1,630 ohms to obtain a balance when the successive contact key K was closed; therefore $E_2 = 1.63$ volt.

For the measurement of current the shunt S is arranged so that the difference of potential may be measured on either side of a known resistance placed around the battery or inserted in the circuit whose current is to be measured. For instance, if one ohm is inserted in any circuit the difference of potential at its terminals has the same value as the current flowing. Therefore a direct-reading voltmeter or ammeter is obtained which still leaves the bridge serviceable for the ordinary measurements of resistance and insulation.

The internal resistance of a battery may be obtained by first measuring its E. M. F. with the shunt S open, which is E; then with, say, the 10-ohm coil thrown around the battery, which may be E'. Then the resistance of the battery $= \frac{E - E'}{E'} \times 10$. It is convenient to have shunt coils of 0.1, 1. and 10 ohms, respectively. To calibrate the dry battery insert a Latimer-Clark or Daniell cell with r, which, with the Daniell, might be 1.079 ohms; then adjust the compensating coil C until a balance is obtained.

After Mr. Lyon had concluded his remarks, Mr. J. Stanford Brown took exception to the statement with regard to commercial ammeters for measuring powerful currents, saying that there were no accurate ones, *i. e.*, accurate within even 5 per cent., on the market. He then described in outline the method of measuring potentials of alternating-current circuits through converters with known reduction factors, etc.,

Mr. Charles E. Emery made some remarks on a bridge method of measuring low resistances, by which, with a little care, the same instruments could be used within considerable limits.

In reply to an inquiry, Mr. Lyon stated that the temperature of the rheostat coils was never affected in ordinary battery measurements. In the case of large currents, as high as 1,000 amperes could be determined by getting the drop in potential through a known resistance, as he had shown.

Mr. Lyon was given a vote of thanks and the president then announced the following committee as appointed to represent the Electrical Department of the Institute at the World's Fair in 1893: J. Stanford Brown, W. D. Sargent, W. S. Barstow, E. F. Peck and F. V. Henshaw.

IMPROVEMENTS IN ANNUNCIATOR AND BELL WORK.[1]

BY CHARLES G. ARMSTRONG.

The subject of which I will speak will be that of electric bell and annunciator service, especially in large and complicated installations. It is indeed strange, that while all other branches of electrical work have been pushed forward, this one important branch has been seriously neglected. It is almost considered a disgrace for an electrician to be a bell man, in fact it requires some considerable degree of courage for one to announce publicly that he professes to engage in that particular line of business; but I wish to assure you that there is no business where a good class of men are more needed than in bell, annunciator, burglar alarm and district telegraph work, as it requires a better knowledge of electricity and a clearer head than to know how to run the simple parallel lines for electric lighting purposes.

History tells us that James Marsh, an Englishman, in 1824 invented an electric bell which consisted of a pendulum, vibrating automatically between the poles of a permanent magnet. John Mirand, in 1850, invented the electric bell practically as it is to-day, using the vibrating hammer, a push-button, an annunciator, and all of the kindred appliances, for which he obtained a British patent in the year mentioned. Now, strange as it may seem, all inventors turned their attention to a better method of producing electricity before they thought of bettering the supply of current for the electric bell.

In the rush to perfect the electric light, the electric bell and the annunciator, with its modifications, the burgular alarm, were left almost as they were invented, with very few improvements. But of all the neglect of improvement in this particular line, that which received the least attention was the generator of current for bell or annunciator work. It is true that good batteries can be obtained, but it is also true that good batteries are very poor at best.

Let us take, for instance, the large modern hotel with, say, 500 rooms. That means 500 bells, 500 annunciator drops, one or two dozen extra bells, chamber maids' calls, fire-alarm gongs and porter bells. It means an extensive system of speaking tubes which are within themselves almost useless without the ever ready electric bell, and perhaps, on the whole, it will mean 1,200 electrical appliances, scattered over a building which may cover an acre of ground, or more, and distributed over from 6 to 10 stories or more in height.

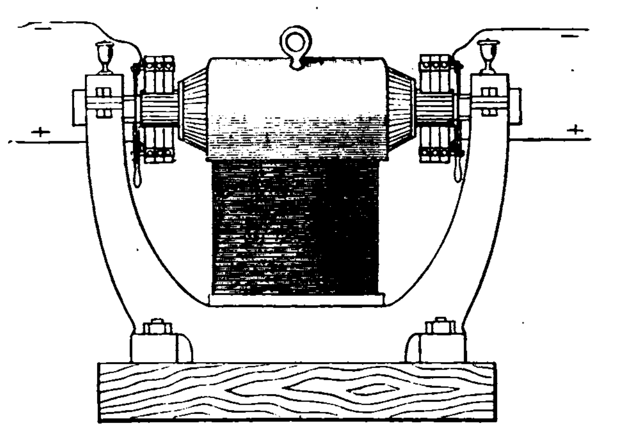
How are you going to handle all these bells? By batteries, of course; there is nothing else. But let us see if there may not be a better way. I present to you a drawing of a machine which was designed by me some years ago and which we will call the battery dynamo. I do not claim to be the inventor of this dynamo but do claim to be the first to use this peculiar form of generator for electric bell service. Since I have had this machine in operation, Professor Thomson and others have used what they call a constant-current transformer, which is very similar in form but entirely different in winding. The drawing which I exhibit is of this little machine which was built for me by Mr. Elmer Sperry and which consists of a bifurcated field having two windings, one end of which is a motor and the other end a dynamo or generator. The armature is double, the two windings being entirely insulated from each other. The motor end is a small shunt-wound motor, wound for 110 volts or any other voltage that one may wish to use and is connected to some convenient supply of electricity, such as may be had in any large city. In many cases you will have that supply within your own buildings, as modern hotels generally have an independent plant that runs night and day; or current can be obtained from some public vender of electricity. The winding of the generating armature is so proportioned that it will give from 1 to 2 amperes at 25 volts pressure, according to the requirements of the plant. I find, however, that this is about the proper current to use.

Now the windings and conditions under which the armature works are such that on a short circuit, the greatest current developed would not be dangerous in any degree to the machine; in other words while having a generator at once desirable and unvarying, you will also have a machine that will run 24 hours a day year in and year out, with scarcely any attention and will give current at all times as desired.

From this dynamo we will carry leads or battery wires with fair cross-section and good insulation. These leads will be run in a looped circuit for equal potential. The loops will have sufficient resistance, when taken together with the resistance of each bell, such that no bell will be overloaded and all will get just enough current to give the best results.

With this arrangement there is no corrosion, no liquid to evaporate, no zincs to waste, no dirty, expensive and unreliable chemical batteries to work with.

Let us now take the case of the batteries. We have the annunciator system, most likely divided into three or four stations, each station being run with from 10 to 20 cells of battery, until, when completed, we will have from 50 to 150 cells of battery scattered throughout the house at such points as we can find space for them, for nobody ever heard of an architect providing space for batteries. In addition to this unwieldy source of supply we must



A Motor Generator for Hotel Bell Circuits.

keep sal ammoniac, zincs, etc., handy, and we must constantly visit the different batteries to see that they do not freeze or that the zinc is not corroded or some trivial thing out of order by which certain bells are silenced, thus condemning our whole system, which lacks nothing but a reliable source of constant supply.

In considering the disadvantages of batteries, not the least point is that you are compelled to deal with currents of low voltage or else have too many batteries in service. For instance, 1,000 feet of No. 18 wire offers a resistance of 6$\frac{4}{10}$ ohms. It is no exaggeration to state that many circuits in our large buildings are 500 feet long, which would offer a resistance of over three (3) ohms, if it were one continuous wire. A loose binding-post or bad connection would easily raise this circuit to 8 or 10 ohms, which, in connection with a bell of from 4 to 6 ohms and an annunciator magnet of perhaps 1½ to 2 ohms more, would give from 16 to 20 ohms resistance in the entire line. It would follow that with, say, a battery of 10 cells in average condition, giving about 10 volts with large internal resistance, the current would be so feeble as not to operate a sensitive bell, making it possible to have trouble with all apparatus apparently in good condition, while with the battery-dynamo system, with 20 or 30 volts pressure and practically no internal resistance and with the difference of 10 or 15 ohms in the resistance of the line, it would still give sufficient current to ring the bells, and nothing but an absolute break in the line would render the service inoperative.

In regard to call bells, my plan is to place in every room a bell connected with a push-button at the hall door with no connections whatever to the office, treating each room as if it were a private residence. I connect this circuit to the ever ready looped mains leading from the battery dynamo. This method has many points to commend it, not the least of which is the fact that it is of great importance, often, for the patrons of the hotel to depend on certain trains. Many cases of lawsuits for damages have been brought and won against hotels for not having called guests at the appointed hour. The fact that the clerk pushed the button in the lower office would not be evidence in law that he had rung the bell in that particular guest's room, but if the call boy goes to the room mentioned and pushes the button on the outside of the door, he can hear the bell ring and can also receive an answer from the guest that he has been awakened, which would be good

1. Abstract of a paper read before the Brotherhood of Electrical Mechanics, Chicago.

evidence in law and would protect the hotel against any claims for damages.

Further, I do not approve of placing annunciators on different floors of hotels or placing annunciators in the office of hotels, except they be very small ones. A room should be provided near the main office for electrical apparatus, in which the telephone, annunciator or annunciators, speaking tubes and all such apparatus should terminate. This room should be placed in charge of a competent, intelligent young man who has some knowledge of electricity. Sub-offices can then be placed on the various floors which will connect with this main office by speaking tubes, or better yet by pneumatic tubes. All calls will then be placed on record and transmitted to the nearest call boy station and executed with the least amount of delay.

In regard to wire, except your building be entirely of wood, do not use annunciator wire and do not use bare rubber-covered wire, for neither is as good as plain weather-proof. The cost of braided rubber-covered wire is so high as to be practically prohibitory. But weather-proof wire, where saturated with some petroleum compound, I find to be a splendid wire for such purpose, from the fact that it is moisture proof and that it is practically free from damage by mice or rats which are the worst enemies of wire that I know of. Mice dearly love rubber and a very small quantity of moisture will ground an annunciator wire, while weather-proof wire is offensive to mice and rats on account of its waxy covering, and is sufficiently impervious to moisture to make it very efficient for this class of work. It is true that it costs more than annunciator wire, but the first cost only is to be considered, and in no first-class installation, such as I am describing, will the architects or owners object to paying the small additional cost in order to have the better satisfaction, which invariably follows the use of good material. In selecting wire be sure to get one very heavily saturated with compound, the more, the better, as it not only protects from rats and mice but from moisture and abrasion. I admit that in wooden buildings where lath and pine studding is used, annunciator wire will do very well for use, but when you consider that bare wire, properly placed under the same conditions, would answer nearly as well, you will see that it is no recommendation for the annunciator wire.

As to the manner of laying wires in the modern fireproof structures with tile partitions, I prefer to use the paper tubing which is now manufactured under the name of interior conduits. One sample is covered with brass. This is designed to use where it is necessary to have the wires exposed. There are a few cases perhaps where it may be necessary, but it can be polished and made very ornamental if desired. The other tube is to be covered entirely by the plastering and offers a channel into which the wires can be drawn at any time. In the halls at suitable points I place wooden troughs, concealed by the decorations, so that every wire in the building can be inspected from end to end without taking up a carpet, removing any plastering or in any way disturbing the occupants of the building.

It has been my object for many months to improve in every way possible the present method of laying wires within large buildings, and I always keep in view the fact that accessibility to the wires is the greatest object to be attained in work of this kind. The architect who spends months designing the beautiful decorations for our modern buildings is certainly not to be blamed for losing his patience when, on account of faulty insulation, the wires have to be torn out and his decorations totally destroyed or marked by patching which is never satisfactory. By the proper design and arrangement in conduits, every inch of the wires, from the annunciator to the push-button, can be drawn out in a few moments and repaired in case of accident from any cause whatever.

In regard to district telegraph or fire-alarm work, this battery dynamo is equally as efficient as it is for bell work, as it at once does away with the uncertainty of batteries, concentrates your apparatus and greatly reduces the cost of maintenance. In the city of Chicago, which undoubtedly has the best fire-alarm system of any city in the world to-day, there are in service nearly 8,500 cells of battery. This does not include the batteries used in Hyde Park and Englewood. It would be perfectly feasible to replace every cell with from six to 10 of these little machines.

In closing my remarks I would like to say to each and every one of you, Make it your object to discourage and discountenance everything in electricity that is bad, and encourage that which is good.

In this connection I will call your attention to two things which I wish to emphasize in particular. First, the placing of electric gas lights on fixtures which carry electric lights. It is the practice in work of this kind to ground one side of the battery. Now as you are all well aware, the fixture man has gone to considerable expense and taken valuable time to place on every fixture an insulating joint, the object of which is to entirely separate that portion of the electric light which is most apt to ground, from the sockets and pipes, which of course afford excellent ground. You proceed to undo all this work by bridging over his insulating joint with the gas lighting wires which are little better than bare wire, so far as insulation goes, and practically annulling the effect of the insulating joint.

Another dangerous thing is the electric trap-door, and there is a building in this city where a sort of "dead fall" controlled by an electric trigger is placed at every point of exit. Hundreds of people, men, women and children are employed in that building every day. In case of fire, every stairway, the elevator shafts, and almost every means of exit will be automatically closed. Against such devices as this I should expect to find you all arrayed.

ON POLYPHASAL GENERATORS.[1]

BY M. I. PUPIN, PH. D., COLUMBIA COLLEGE.

FEW will deny the importance of the polyphasal current systems; none the fascination of their study. This belief induced me to present the following brief essay before the Institute.

The experimental researches in this new and promising field of electrotechnics are not yet numerous, but still the results already obtained are of so decisive a character as to leave no doubt whatever as to the extremely high practical importance which is attached to electrical generators, motors and transformers constructed according to requirement imposeds upon us by this new

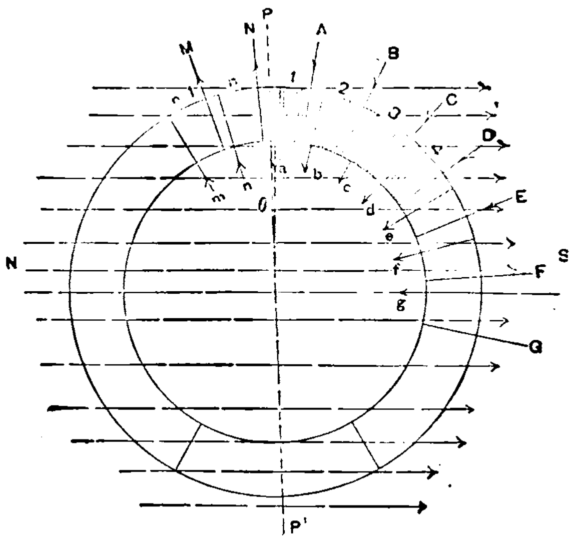


Fig. 1.

method of combining a set of variable electromotive forces. For who among us does not thoroughly appreciate the beautiful inventions of Nikola Tesla and the completeness of the success which Dobrowolsky and Brown obtained by the practical applications of these inventions?

The exact quantitative relations involved in the polyphasal system of currents are not, I venture to say, quite as well known as its practical results. To give an impulse to further inquiry in that direction is one of the principal aims of this modest investigation. For the present I propose to confine myself to the polyphasal generators in general, and particularly to polyphasal generators whose system of electromotive forces is capable of producing a rotary magnetic field of constant strength. The last point seems to me to be one of the vital points in this new method of electrical distribution. It is in this particular point that Mr. Dobrowolsky claims his system to be superior to that of Nikola Tesla.

Let us consider the theoretically simplest form of a polyphasal generator, as shown in Fig. 1. A non-magnetizable ring with n open equal coils at equal distances from each other rotates uniformly through a perfectly homogeneous magnetic field. Let PP′ be the neutral plane of the field. At the instant when coil 1 is at the angular distance θ from the neutral plane PP′ the E. M. F. generated in the various coils will be

$$e_1 = K \sin(\theta + \alpha)$$

$$e_2 = K \sin\left(\theta + \alpha + \frac{2\pi}{n}\right)$$

....

....

1. Read at the sixty-second meeting of the American Institute of Electrical Engineers, New York, December 16th, 1891.

$$e_n = K \sin \left\{ \theta + \alpha + (n-1) \frac{2\pi}{n} \right\}$$

Where K is a constant depending, as is well known, on the field intensity, the speed of rotation, the number of turns in the coil and the area of the plane of a turn; α is the angular width of one-half of the coil.

Since

$$\sin(\theta+\alpha) + \sin\left(\theta+\alpha+\frac{2\pi}{n}\right) + \ldots\ldots + \sin\left\{\theta+\alpha+(n-1)\frac{2\pi}{n}\right\} = 0$$

it follows that

$$e_1 + e_2 + e_3 + \ldots\ldots + e_n = 0 \ldots\ldots (1).$$

That is to say, the sum of electromotive forces generated in the various coils which are on one side of the neutral plane is numerically equal and of opposite sign to that of the coils on the other side of this plane. This result is well known and self-evident. It is, however, far from self-evident that relation (1), which I shall call the *relation of continuity* for the electromotive forces, will be satisfied by every magnetic field.

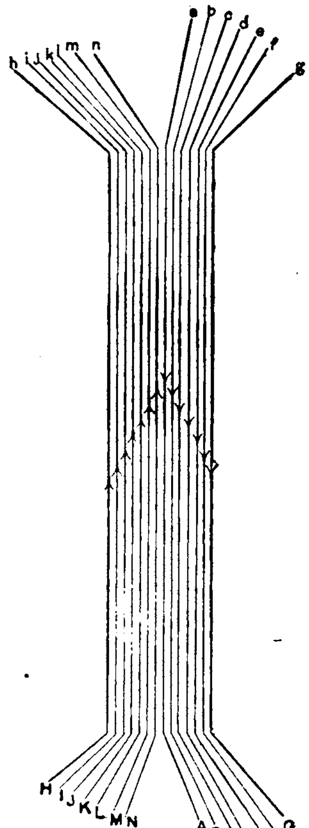


Fig. 2.

Close each coil separately by conductors of equal resistance and self-induction. Let $c_1, c_2 \ldots\ldots c_n$ denote the currents in the n separate circuits. It is evident that

$$c_1 = \frac{K}{I} \sin(\theta + \alpha - \varphi)$$

$$c_2 = \frac{K}{I} \sin\left(\theta + \alpha + \frac{2\pi}{n} - \varphi\right)$$

$$c_3 = \frac{K}{I} \sin\left(\theta + \alpha + 2\frac{2\pi}{n} - \varphi\right)$$

$$c_n = \frac{K}{I} \sin\left\{\theta + \alpha + (n-1)\frac{2\pi}{n} - \varphi\right\}$$

Where I is the impedance in each circuit and φ the angle of retardation. Hence, we have

$$c_1 + c_2 + c_3 + \ldots\ldots + c_n = 0 \ldots\ldots (2).$$

That is to say, the relation of continuity is satisfied for the currents also.

Let the wires $a\,A$, $b\,B, \ldots\ldots n\,N$ (Fig. 2) represent a part of each of the n conductors of this system. Then, according to relation (2), the sum of the currents in these n linear conductors being always zero, if we join them all into one conductor there would be no current in this wire, but the currents in the n circuits would circulate exactly the same as before. In fact, the common juncture is useless and can and should be cut out.

The diagram, Fig. 3, represents this method of connecting for a three-phase system. Consider, now, n equal coils distributed at angular distances of $\frac{2\pi}{n}$ over a laminated iron ring B, each coil being a part of the n conductors coming from the generator Diagram Fig. 4 illustrates this for a three-phase system. Let the n currents be denoted now by $c_1', c_2', \ldots\ldots c_n'$. We shall have now,

$$c_1' = \frac{K}{I'} \sin(\theta + \alpha - \varphi')$$

$$c_2' = \frac{K}{I'} \sin\left(\theta + \alpha + \frac{2\pi}{n} - \varphi'\right)$$

$$c_n' = \frac{K}{I'} \sin\left\{\Theta + \alpha + (n-1)\frac{2\pi}{n}\varphi'\right\}$$

and therefore

$$c_1' + c_2' + \ldots\ldots + c_n' = 0 \qquad (3)$$

The introduction of the iron ring with the n coils into the n phasal system has changed the impedance I, and the angle of retardation φ; but this change is evidently the same for all coils. The correctness of this statement might, perhaps, be questioned, if we suppose that the system of the n variable currents was at any moment strong enough to saturate the iron ring; I therefore suppose that the intensity of magnetization in the ring is never over 10,000 C. G. S. lines of force. We shall presently see that in the case of a properly built generator the saturation of the iron ring will not vitiate the correctness of the above statement in the slightest.

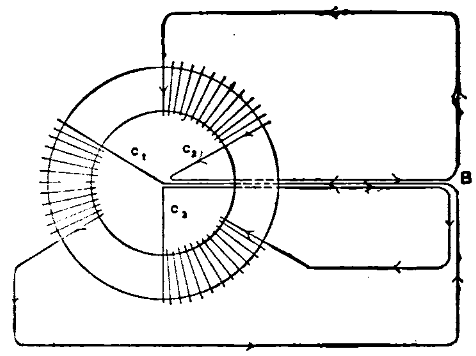


Fig. 3.

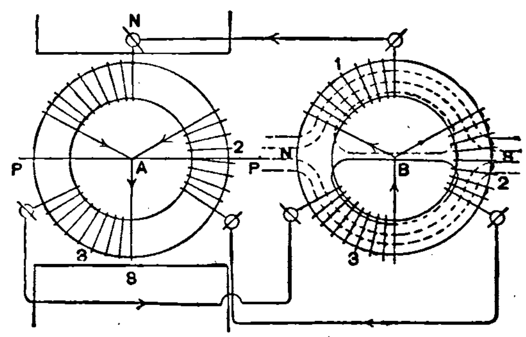


Fig. 4.

Let s be the number of turns in each of the n coils. Relation (3) gives

$$4\pi s c_1' + 4\pi s c_2' + \ldots\ldots + 4\pi s c_n' = 0 \qquad (4)$$

That is to say, the relation of continuity is satisfied by the magneto-motive forces.

Relation (4) translated into physical language means that the magnetization in the iron ring is due to two equal magneto-motive forces working in multiple arc. The magnetic field produced is perfectly symmetrical with respect to the ring as indicated by the dotted lines in Fig. 4.[1]

MR. C. O. HARRIS, formerly of Clower, Harris & Co., Dallas Tex., was in the city last week. Mr. Harris has secured some excellent agencies, and will open an office in Dallas.

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1. This will be always strictly true if we employ an even number of coils, even if the number of phases is odd, because then the distribution of the ampère turns is perfectly symmetrical.

SOME PRACTICAL FORMULÆ FOR STREET CAR MOTORS.

BY

Thorburn Reid.

THE following analysis was undertaken with the object of obtaining some simple, practical formulæ, which could be used by a practical man in his everyday work. Accuracy has been sacrificed to simplicity, since accuracy in this case would hardly be required by the engineer, and, if it were, it could seldom, if ever, be attained on account of the wide variations in the conditions affecting the problem.

First take the case of a gramme ring armature in a two-pole field, the field coils being in series with the armature coils. If e is the counter E. M. F, S_2 the number of turns on the armature, n the revolutions per minute, and N the number of volt lines (10^8 c. g. s. lines = one volt line),

$$e = S_2 N n. \qquad (1)$$

But $N = \frac{S_1 C}{\rho}$ where $S_1 C$ is the number of ampere turns in field and ρ is the magnetic resistance of the magnetic circuit. Therefore, $e = \frac{S_1 S_2}{\rho} C n$ (2)

If R be the resistance of the field plus the armature, and E the line E. M. F., then

$$C = \frac{E - e}{R} = \frac{E - \frac{S_1 S_2}{\rho} C n}{R}$$

solving for C, we have

$$C = \frac{E}{R + \frac{S_1 S_2}{\rho} n} \qquad (3)$$

If w be the work done by the motor,

$$w = C e = \frac{S_1 S_2}{\rho} C^2 n \qquad (4)$$

S_1 and S_2 and ρ are constants of the motor. ρ, however, varies somewhat with the saturation of the field. We will not, however, introduce too large an error by considering it constant throughout the range. If, therefore, we substitute for $\frac{S_1 S_2}{\rho}$ the letter a, a constant, (3) and (4) become

$$C = \frac{E}{R + a n} \;\; (3) \qquad w = a\, C^2\, n \;\; (4).$$

The value of this constant may be obtained easily if we have the dimensions of the magnetic circuit and a saturation curve of the iron in field and armature, but this, in the present stage of electrical manufacture, is not generally to be had. The following method is far simpler, and no doubt more accurate:

Let the motor whose constant is required be run under load and a reading be taken of E, C and n. Substituting these values in equation (3) we may obtain the value of a thus: $a = \frac{E - C R}{C n}$ (5)

This may be made more accurate and the variation in ρ taken into account by taking readings at varying loads and currents and obtaining the value of a for each case.

The value of a thus obtained will then be good for all motors of that type and size for all practical purposes. Of course, if the number of turns on field or armature be varied, the value of a will be changed.

If the motor be of the four-pole type, or if its armature be a Siemens instead of a Gramme ring, the same equations may be used, provided a is obtained by experiment, as above; for in the former case the only change to be made is to multiply n by 2, which, being a constant, would be included in a, and in the latter case the right-hand member of equations (1) and (2) would be multiplied by 2, which would again be included in a, since (2) could be written, $e = a\, C\, n$. Another convenient formula is the following:

If m be the speed of the car in miles per hour, d the diameter of the car wheel in inches, and r the ratio of reduction, or the ratio of the revolutions of the armature to those of the car wheel, we will have

$$n = \frac{5280 \times 12 \times m \times r}{60 \times \pi \times d} = \frac{304\ m\ r}{d} \qquad (6)$$

Having obtained the value of a, then the next step is to apply these equations to problems occurring in practice. A problem, which often occurs, is, what E. M. F. is required on the overhead line to drive a car up a particular grade at a certain rate of speed.

From (3) we have $E = C (R + a\, n)$ in which everything is known except C. But C can be obtained from equation (4), provided we know the value of w. w depends on five things—friction, grade, condition of track, curvature of track and speed. No general formula can be given for the resistance due to friction, condition of track or curvature. These can only be determined by experience and must be largely a matter of guess-work. The friction will vary largely at different times in the same car, depending on the care with which the gears and bearings are oiled and on whether the track is wet or dry, clean or dusty or muddy. A rough value may be arrived at by taking readings of the current and line E. M. F. at varying speeds with the car running on a level, straight track. This resistance may be taken to vary directly with the weight of the car plus its passengers. We obtain w by substituting these readings in equation (4). We find the work required to overcome the grade as follows:

$$w_g = \frac{P \times \mathit{ft.\ per\ min.} \times 746 \times g}{100 \times 33{,}000}$$

where P is the weight of car plus passengers and g is the grade in per cent. That is, the rise in feet per hundred feet. Or $\qquad w_g = .02\ m\ g\ P$

where m is as before the miles per hour.

The work which would be done by the motors then in climbing the grade will be that obtained by equation (7) plus the work required on a straight, level track, since this latter factor is assumed to be constant whether the car is going up or down grade or on a level.

In making the experiments to obtain w on a level we must be careful to notice the load that the car carries, since this work at any speed varies directly as the weight of car plus its passengers. Probably the simplest procedure would be to divide the work thus obtained by the weight of cars plus passengers, thus obtaining the work for one pound, which can then be multiplied by the total weight (average weight of a full-grown passenger may be taken to be 125 pounds), calling this value w_1, the complete formula will be

$$w = P (w_1 + .02\, m\, g). \qquad (8)$$

Of course, w_1 must be determined for the same speed as that required at the point in question or else it must be estimated from the data at hand. Probably the best assumption we may make is that the work on a level varies as the speed, or

$$w_1 = b\, n \qquad (9)$$

b being a constant depending on the condition of the road-bed, etc., and is most easily determined by running the car and taking readings of C, E, and n, substituting for w_1 and n in equation (9) and solving for b.

Having thus obtained the value of w, we may substitute it in (4) and obtain C and then substitue C in (3) and obtain (E). We are thus enabled to determine the size of wire required in the feeders to maintain a certain speed at any point on the line.

Society and Club Notes.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

THE fifteenth convention of the Association will be held at the Iroquois Hotel, Buffalo, N. Y., on February 23, 24, and 25. Secretary Porter announces that Mr. C. O. Baker, Jr., has been appointed general master of transportation with headquarters at the office of the Association, 136 Liberty street, where all communications relating to transportation should be addressed. Steps are already being taken to make the meeting a great success.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

AT the meeting of the council on December 16, the following gentlemen were admitted to associate membership:

Ayres, Brown, professor of physics and electrical engineering, Tulane University, New Orleans, La.

Benjamin. Park. electrical expert and engineer, 32 Park Place, New York City.

Bishop, James Draper, electrical expert, John A. Roeblings' Sons Co., 845 West Thirty-fourth street, New York City.

Parcelle, Albert L., electrician and inventor, 157 Washington street, Boston, Mass.

Pike, Clayton W., instructor in electrical engineering, University of Pennsylvania, Philadelphia, Pa.

Robb, Wm. Lispenard, professor of physics, Trinity College, Hartford, Conn.

Applications for transfer from associate to full membership, as follows, were approved:

Smith, T. Carpenter, firm of M. R. Muckle, Jr., & Co., Philadelphia, Pa.

Taintor, Giles, assistant electrician, N. E. Tel. & Tel. Co., Boston, Mass.

Pattison, F. A., firm of Pattison Bros., consulting and constructing electrical engineers, 135 Broadway, New York.

THE FRANKLIN EXPERIMENTAL CLUB.

THE Franklin Experimental Club, of Newark, N. J., has changed its regular meeting night from the second and fourth Tuesdays of the month, to the second and fourth Saturdays in the month. There has been a considerable increase in the membership of late and a committee has been appointed to look for larger and more suitable quarters, the club having outgrown its present facilities. Among the subjects that have been taken up at the recent meetings, are "Induction," "Construction of Transformers and Applications of Alternate Currents," "Vibratory Phenomena." A series of talks illustrated by experiments are now being given upon the latter subjects by the various members, illustrating in a most interesting way the phenomena of sound, light, heat, and electricity, and their correlation.

THE BOSTON ELECTRIC CLUB.

MR. R. F. ROSS, secretary of the Boston Electric Club, writes us:

It having been announced in some of the electrical journals that "the New England Electric Club is to be formed to take the place of the Boston Electric Club," will you kindly, in justice to the Boston Electric Club, state in your next issue that such is not a fact. The Boston Electric Club is not dead, nor have we surrendered our charter. We have simply given up our permanent headquarters and disposed of our furniture and effects. Henceforth the club will be perpetuated in the form of monthly dinners, lectures, etc. Our constitution and by-laws have been revised, annual dues reduced to an almost nominal figure, and such other changes made that we think will tell beneficially, and on the first Monday evening in January (the 4th), we propose having our Inaugural Dinner. I know nothing of the New England Electric Club except what has been published nor, have I seen any one who can tell me anything about it.

College Notes.

ELECTRICAL ENGINEERING AT THE A. & M. COLLEGE.

THE trustees of this college (Birmingham, Ala.) are keeping in progress with the age, and have established a Special School of Electrical Engineering and equipped a laboratory with different styles of dynamos and electrical appliances for instruction in the applications of electricity. We are indebted to Prof. A. F. McKissick for an interesting little pamphlet on the subject. The equipment is still small, but it is the intention of the Alabama Polytechnic Institute to build it up year by year.

Reports of Companies.

THE CARD ELECTRIC MOTOR CO.

CHANGES in the management of the Card Electric Motor Co. during the last few days started the rumor that this company had failed; in fact such information was telegraphed to a number of cities. However, THE ELECTRICAL ENGINEER, having a representative in the vicinity, immediately took steps to ascertain the true state of affairs. It seems that the entire concern has been purchased outright by Mr. J. W. Wilshire, with a view to its immediate re-incorporation under the laws of Ohio, it having been heretofore under the laws of Kentucky. Mr. Dixon, the efficient general manager of the old Card Company, will remain in that capacity with the new organization. The wealth of the individual stockholders of the Card Electric Motor Co. made it seem incredible that the house was going into the hands of a receiver. In the meantime we are informed that most of the creditors have only recently received checks in full settlement of their accounts—another very good indication of the condition of the company's finances. Mr. Wilshire expects to have things running along smoothly under the new regime in the course of a few weeks, and in the meantime the factory is working "full blast" as usual.

Appointments, Etc.

MR. W. H. GIRVAN, general superintendent of the Central New York Telephone Co., with headquarters at Syracuse, has handed in his resignation, to take effect Dec. 31. The resignation has been accepted, and Walter W. Nicholson, of Utica, has been appointed to fill the position. Geo. W. Wood, who has been division superintendent in Herkimer county, with an office in Little Falls, will succeed Mr. Nicholson as division superintendent for Oneida, Madison and Lewis counties. Mr. Nicholson, the new general superintendent, is a son of General Manager Charles A. Nicholson, of Utica, formerly of Rome. He will have his office in room 46, Mann Building, Utica, on the same floor with the executive offices of the company.

MR. GEORGE ALBREE has assumed the duties of superintendent of the Boston division of the New England Telephone Co., relieving Mr. Denver, who will continue to serve as assistant to Mr. Keller.

MR. HOMER E. MASON has succeeded Mr. H. A. Wyckoff as superintendent of the Delhi Electric Light Co., of Delhi, N. Y.

Personal.

MR. GEORGE NORTH, M. I. M. E. and A. I. E. E., who has been for some years general manager of Woodhouse & Rawson United, Limited, the well-known electrical and mechanical engineers of London, England, has resigned his appointment in order to commence business as a consulting engineer, valuer and arbitrator, at 90 Queen street, London, E. C. A special feature of Mr. North's business will be the purchase, sale and development of new patents and inventions; and he will also act as London agent for mechanical and electrical specialties.

Obituary.

W. H. BAUER.

MR. W. H. BAUER, one of the oldest telegraph operators in the country, died on December 14, at his residence, Baltimore, Md., of pneumonia. Mr. Bauer was 73 years of age and had been an operator since 1846. He worked for the Southern Telegraph Company until its amalgamation with the Western Union, when he went into the employ of the Baltimore and Ohio, where he remained up to twelve years ago, when he returned to private life. Mr. Bauer took an active interest in Masonry. The son of the deceased, Mr. Alexander H. Bauer, the electrical engineer of the Pullman Car Company, came on from Chicago to attend the funeral. Mr. Bauer was buried with Masonic honors.

Letters to the Editor.

REACTIVE COILS AND THE RIES REGULATING SOCKET.

IN your issue of Dec. 16th, Prof. Elihu Thomson, in commenting upon Mr. Otis K. Stuart's article on "Reactive Coils," published in your issue of the previous week, takes occasion to criticise the results obtained by the Ries Regulating Socket, kindly referred to by Mr. Stuart as being probably the most interesting application of the reactive coil principle, and at the same time endeavors to show that he anticipated the invention in his patent No. 428,647, and states that he had in operation some years ago several such "regulating arrangements" in his house in Lynn.

In view of Prof. Thomson's own admission that the principle involved in the construction of reactive coils was known many years before he was born, and in view of the fact that not only reactive coils, but reactive coil regulators were well known in the art and had long since been used by myself and others for regulating the flow of alternating current to incandescent lamps and other translating devices, it is scarcely necessary for me to say that a patent describing a specific improvement in reactive coils, as does the one referred to by Prof. Thomson, is not only something entirely different from a regulating socket, but scarcely amounts to an invention over the prior art in view of the earlier patents to Hopkinson (Eng. 3,362 of 1881) and others, showing substantially the same arrangement.

The use of reactive coils for regulating groups of lamps, of which Thomson's patent referred to is an example, has been customary in isolated cases almost since the introduction of the alternating-current system of lighting in this country, as exemplified by the well-known but somewhat bulky "stage regulator" in common use; and it is quite probable that the "regulating arrangements" used in Prof. Thomson's house were of this character. I venture to say (and I am supported in this assertion by Prof. Thomson's closing sentence) that, despite the professor's ingenuity and varied experience with alternating-current apparatus, he had not only never made, but had never even *thought it possible to construct*, prior to the time he experimented with the Ries regulating socket, a reactive coil small enough to go into a lamp socket and yet perform the work required of it as thoroughly and efficiently as this socket does it.

In regard to Prof. Thomson's statement that the economy effected by the Ries regulating socket is "problematical," all that need be said is that if the professor had taken the time to measure the amount of energy consumed by the lamp and socket at the lower stages of light, upon one of his own wattmeters (provided he had one sensitive enough to measure it), and compared the result with the number of watts consumed by the same lamp at full candle power, he would have found this method of regulation to effect a very considerable and most surprising economy that would at once have settled any lingering doubts he may have had on this question. Of course, it is well known that, as stated by him, a certain amount of energy is absorbed in heating the filament before it reaches the incandescent stage, but it is a fact not so generally known that the energy thus absorbed forms an exceedingly small fraction of the total number of watts required to raise the lamp to full candle power.

While the writer is not as yet at liberty to go into a detailed description of the socket, he may say that by its use he has been enabled to burn from eight to ten 25 c. p. incandescent lamps at a dull red glow, sufficient to enable one to locate the position of each lamp in the dark, at a consumption of less energy than was required to burn one of these lamps at full candle power. As the light is turned down, not only the current, but the electromotive force at the lamp terminals necessary to pass this current through the filament, is reduced. And since the efficiency of the socket itself, owing in part to its peculiar construction, is almost perfect under the conditions noted, the amount of energy consumed in producing this light is exceedingly small.

It is true that lamps are much more efficient when burning at high than at low candle powers, but this fact, if it has any bearing at all upon the socket, only makes it the more valuable, for the reason that the socket is not merely capable of burning the lamp at its normal brilliancy or candle power the same as any ordinary socket, and is ordinarily intended to be so used when the usual amount of light is desired, but because by its use the consumer is enabled to burn his lamps, if the latter are of the proper voltage, *above* as well as *below* their normal candle power. It will therefore be seen that by means of this socket the consumer is not only entirely independent of the variations of potential that are constantly occurring on the line from occasional overload and other causes, and which frequently prevent him from obtaining sufficient light, but he is enabled at all times to obtain a maximum amount of light, when much light is wanted, at a higher lamp efficiency and therefore at a proportionally less cost per candle power for current, as well as to turn down the light and thus save both current and lamps when less light is desired, or to keep ome of his lamps burning at a still lower degree of brilliancy during the entire night where, under the present conditions, they would be turned out altogether. In short, this socket gives the consumer complete control of his own lamps, and for the first time places the incandescent electric light upon an equal footing with gas, in that it permits him to burn much or little light, as he may desire, during the time his lamps are in service, and at a cost for current directly proportional to the energy consumed.

The history of invention shows that it is an exceedingly simple matter after a thing has been successfully done, to see how something else *might* have been made to do the same thing. But the fact remains that, despite the great demand that exists and has always existed since the invention of the incandescent electric lamp itself, for a simple and efficient holding device that would permit of turning the lamp up and down without waste of current, and despite the further fact that reactive coils of the ordinary type have been for several years in almost daily use by many of the most prominent electricians and experimenters of the world, and have occupied a foremost place in nearly every electrical laboratory and workshop, it has nevertheless remained for the writer to produce the desired article to successfully supply this demand by the invention of the Ries "Regulating Socket." It is perhaps needless to add that alternating current incandescent lighting is already beginning to feel the impetus that this socket has given to it, and that not only the public generally, but central stations supplying current on the meter system, are reaping a decided benefit therefrom.

ELIAS E. RIES.

BALTIMORE, MD., December 17th, 1891.

THE HUM OF MOTORS.

I WAS much interested in the article by Mr. Charles J. Hayes entitled "The Hum of Motors," which appeared in your issue of December 16, 1891. I have been much puzzled to find a satisfactory explanation of the phenomenon which he discusses, but I am forced to confess that I am unable to understand his explanation of the cause.

Sound-waves in the air are necessarily either set up by the movement of some body surrounded by, or in contact with the transmitting gas, or set up by some force or forces other than those derived from motion. If sound-waves are derived from motion, that motion must be one capable of moving the surrounding air.

Mr. Hayes explains at some length a possible raising or distortion of the armature under each pole-face which, he thinks, though ever so slight, would be capable of setting the air in vibration, as the rotation of the armature shifts the points of distortion along the surface of the armature. In his words: "Now, by revolving the armature it will be seen that every part of its circumference will be brought in succession in front of each of the poles, and, consequently, attracted and slightly raised as it passes, producing a progressive undulatory movement of the iron, like waves on a body of water."

Mr. Hayes' waves, like his hypothesis, may be progressive, but they are not *sound*, and, indeed, I may add they are not even progressive, since it is merely the particles of the armature that progress. The undulatory distortion is fixed in space. His simile of waves on water would better be those fixed waves that one sees on some swiftly flowing rapids where no movement exists save that of the moving particles that lie within the fixed contour of the whole body.

As there can be no movement of the air produced by such fixed undulations, I am unable to find in his supposition any cause of the phenomenon of the hum of armatures. It is this point that I would beg him to elucidate, as, till he does, his speculations are hardly entitled to rank with the less plausible but perhaps more admissible theories already somewhat numerous.

HAROLD BINNEY.

NEW YORK.

THE BURNET ROSETTE AND SWITCH.

IN the early days of the electric light business we learned that the way to invent a dynamo was to take the other fellow's machine and paint it red. This is good doctrine and has been generally accepted and widely followed. Once in a while, however, it happens that the inventor neglects to apply the saving coat of red paint, and I wish to call attention to a very flagrant case of the kind. In the issue of THE ELECTRICAL ENGINEER for December 9th, appears an article with the above heading written by H. W. Burnet, describing a rosette and switch which has been advertised and sold by the Electrical Supply Co. for about a year. As the article referred to does a slight injustice to my company I wish to state the facts as a matter of justice.

The original of the rosette switch in question was designed by me, and the drawing is now before me, bearing date January 18, 1889. It is designated "Ceiling Cut-Out with Off and On Switch," to be operated by one pendant cord. Nothing was done with this until in the summer of 1890 I ordered from Mr. Burnet, for the Electrical Supply Co., two or three models, and later 500 of the cut-outs, which are identical with the half tone shown on page 622 of THE ELECTRICAL ENGINEER of December 9th, 1891. I learn from the *Patent Office Gazette* that Mr. Burnet has applied for and received a patent on this device. This he is entirely welcome to keep for what it is worth, as the particular mechanical action involved has been superseded by a simpler and more satisfactory one.

The whole thing is of the very slightest importance. Sensible inventors are not in the habit of taking out patents on this class of mechanism at all, very much less going out of their way to patent other people's inventions of such small value. I would not waste space and time in calling attention to the matter at all, but for the particularly brazen nature of Mr. Burnet's assumption. In my small experience as an inventor, it has not fallen to my lot before to meet with any one willing to accept orders for models, to build the same according to instructions, to fill an order for goods in quantity built according to such models, and afterwards claim the whole thing and apply for a patent.

CHARLES WIRT.

CHICAGO, Dec. 12, 1891.

Legal Notes.

INCANDESCENT LAMP LITIGATION—THE UNITED STATES ELECTRIC LIGHTING CO. vs. THE EDISON LAMP CO.

ARGUMENT OF FREDERIC H. BETTS FOR THE EDISON COMPANY.

MR. BETTS in opening the case for the defence, remarked that his brother Kerr in his opening as well as in his concluding remarks had made a statement with which he thought he ought to begin; namely, that the case was one of strong equity on the part of complainant. He could not but disagree entirely with that statement. Let us—said Mr. Betts—carry ourselves back and try to appreciate the true status of the several inventors at the time when this invention was made.

About the year 1877 the whole world of electrical thought had been intensely interested in the problem of the production of electric light by incandescence. Many inventors, both in this country and abroad, had been struggling with this problem for more than 30 years. The whole atmosphere of thought had now been quickened by a sense of some impending discovery, which should render practical the dreams of inventors and scientists. Fontaine had in many respects fairly stated the condition of the affairs existing at the time he wrote. He said :—

> Lighting by incandescence has been studied for a long time; but its application generally presents so great difficulties that at the present day it may be considered as within a purely scientific domain, although a certain number of apparatus exists working moderately well.

That had been the condition of affairs in 1877. The best result which had been attained, according to Fontaine, had been an average duration of the carbon of 21 minutes, but in no case had its length of life been greater than two hours. It would seem, therefore, that had anybody really invented anything tending to materially increase the life of the incandescent lamp he would not have been slow to have communicated that momentous discovery to those who were able to appreciate the importance of such an invention. Weston, the patentee in this case, was a well-known electrician, who is and has been for many years an expert. He had been equipped even at that time, with all the requisite facilities for construction and experimentation. He was an expert in words too, with a remarkable facility of stating in the most favorable way to himself any claims which he might put forward. Upon the face of this case there stood out one most important fact. There was no contemporaneous record of the experiments which Weston is alleged to have made. On the contrary, the evidence of the witnesses who have testified in support of his contention wholly fails to corroborate him in respect to the most vital points. He contended that Weston stood wholly alone in his endeavor to prove that he had perfected a process of treating carbon conductors, or that he had applied that process to the making of conductors of incandescent lamps, at the early date assigned by him, the summer of 1877; or that he had then in fact acquired any knowledge or made any discovery in advance of that which the world previously possessed.

Very different was the way in which other inventors had acted in regard to this same invention. Sawyer and Man had been proved without contradiction to have practised this process of making carbon as early as the 6th of March, 1878. They had filed an application for a patent accompanied by a model which contained a treated carbon. Their patent had been issued June 25, 1878. October 15, 1878, they had filed an application for the process of treating carbons, which had been granted January 7, 1879. Weston's application had not been filed until two years and four months afterwards. Sawyer and Man had exhibited their lamps in the most public manner. Large numbers had been invited to see them. The process of hydrocarbon treatment had been employed in their factory. It had been fully described and illustrated in publications more than two years before Weston had applied for his patent. Another inventor, Maxim, testified that he had also practiced this process, that he had made such a lamp as early as June, 1878, and that he had filed an application for a patent in October, 1878. It was idle for complainant to contend that Maxim had not appreciated what he was doing. Maxim had been the electrician of the United States Electric Lighting Company. They had prosecuted his application. They had asserted him to be the first inventor. An interference had been declared between Maxim and Sawyer and Man, in which Sawyer and Man had been successful and had been declared the prior inventors. Maxim had thereupon dropped the contested claim. In June, 1880, the United States Company commenced making lamps. All through 1880 they had made lamps at Bridgeport and late in that year they started up a plant of lamps, lamps made by Maxim and not by Weston. The United States Company were then exploiting Maxim's invention, as appears by an article in the record from the *Evening Post*. Not until the spring of 1881 was Weston first heard of in this connection. Mr. Curtis in his testimony has said that it was in February or March, 1881, that he first formed the acquaintance of Weston. Mr. Betts then read from the testimony the history of the unsuccessful negotiations with Sawyer and Man in relation to this invention. This was in the spring of 1881. Weston had done nothing to get his invention into public notice, while Sawyer and Man had done everything they could do, by patenting, publishing, and manufacturing lamps as well as they could manufacture them. The United States Company had tried to get a license from them and it was only after it had failed to do so that Weston had first been heard of. In a conference in 1881 between Curtis and Weston, Weston had made the claim that he was the inventor. In 1881, after the public had for two years been in possession of the full knowledge of this invention an application had been filed in behalf of Weston. Subsequently, it did not appear when, the Sawyer and Man patents had also come into the control of the Westinghouse Company, which also now controlled the United States Company. Now it had become very important to belittle everything that Sawyer and Man had done, for by means of a patent granted in 1885, this complainant company would obtain control of the invention for a much longer term. There was nothing to show that the application of Weston had ever been thought of by him or by anybody else, until the exigencies of this complainant had compelled it to have an application for a patent made in the name of Weston.

His brother Kerr has contended that the work of Maxim had eventuated in nothing practical, but he did not think that the facts would sustain him in his contention. The first commercial plant had not been made by Weston, nor did he have anything to do with it. He (Mr. Betts), asserted that the public derived a practical knowledge of this invention, not from Weston, but from somebody else. By way of emphasizing this state of facts he would refer to the stipulation in the record. Depositions taken in a suit on the Sawyer and Man patent had been stipulated into a suit on the Weston patent and the suit had been brought on that patent, because it had the longest time to run. It had been admitted by Mr. Pope, the complainant's own expert, that no less than four prior patents—two English and two United States patents—contained a full disclosure of the invention, or sufficiently full at least, to enable a person skilled in the art to practice the invention.

Such a state of facts—continued Mr. Betts—puts upon the complainant the burden of proving, with the utmost certainty and beyond all reasonable doubt, that Edward Weston had completed the invention before any of these others inventors.

Another feature which he should refer to showed that there was no great equity in this case. The Edison Lamp Company did not use this invention in commercial practice. There was proof of a course of experimentation, of a few weeks, or a few months; the making of a few thousand carbons at the lamp factory in 1884 and 1885. There was not one particle of proof that they had ever put one of these carbons into a lamp. The process had been abandoned; it had never been used in a single commercial lamp from the beginning down to the present time. The Edison lamp was made of bamboo, carbonized in a furnace and then electrically heated in a vacuum to drive out occluded gases. It was sealed up by electrically heating, not in a carbonaceous atmosphere, but in a vacuum. The witnesses had testified as to the number of carbons treated; some 20,000 others 9,000, and so on, figures which might sound large, but which were wholly insignificant in view of the fact that at the present time 25,000 lamps per day were being manufactured with untreated carbons, so that the whole amount testified about actually did not amount to one day's commercial production. The defendant had been prosecuted for a mere experimental use of a process which had never been used in its commercial manufacture.

There were three propositions of law to which he should ask his Honor's assent as applied to the facts of the present case.

First.—He is the first inventor, in the eye of the law, who reduces the invention to a fixed, positive and practical form; for until he has done this he is not in a position to give to the public what it has a right to demand. In a race of diligence between two inventors, he is not the inventor who first conceives the possibility of producing a certain result, but he who so perfects the invention that its utility, practicability and success, for the purpose for which it is intended, is actually demonstrated, or is capable of being demonstrated to those who see it. *Second*, if the party first to conceive and subsequently to reduce the invention to practice. does not use reasonable diligence in asserting his rights, and in the meantime the public derives a knowledge of the invention from other sources, or if by other inventors the public have been put in possession of the invention by public use or sale, he loses his rights. *Third*, when the burden of proof is upon a defendant to establish the date of his invention and patent, his proof must be of such a character as to be beyond all reasonable doubt. The rule is the same as against the plaintiff, when once the defendant, as in this case, has succeeded in shifting the burden of proof, by establishing beyond a reasonable doubt that some party other than the plaintiff's patentee, had, prior to the date of the patent, made the same invention. The burden of proof being thereby shifted, it becomes incumbent upon Weston and those claiming under him to adduce the most positive proof in support of his contention. Mr. Betts read from the opinion in *Thayer* vs. *Hart* (22 Blatchf., 229) which, he contended, applied precisely to the present case. He contended also that the evidence in behalf of Weston had proved nothing more, at most, than the performance of some abortive, inconclusive, and uninstructive experiment.

Mr. Betts next proceeded to analyze the patent in suit. He said that the preamble was almost exactly plagiarized from Sawyer and Man's English patent. Weston had nevertheless recognized the state of the art as shown in Despretz's experiments. He then read an account of Despretz's experiments, as published in the *Chemist* in 1849-1850, in which carbon rods had been electrically heated in a hydrocarbon atmosphere, and said that the statements of the experimenter showed precisely what the effect would be in all cases.

A careful perusal of the specification showed that it drew a distinction in the result or stated two different results; first, the filling up of the pores, rendering the carbon more dense and reducing its resistance, and second, building up the surface, or if irregular in diameter or resistance every part of the carbon is made of equal resistance or diameter. His Honor would find that the claim of the patent had been carefully limited to the process of "building up", and had moreover been so limited by the Patent Office. It was not for a general, but for a particular use of the process for building up the carbon. Next he would refer to the file-wrapper and contents and see what Weston's original claim was:—

The method of preparing carbon and conductor for incandescent lamps, by electrically heating them while surrounded by or saturated with a carbonaceous substance, as described.

His Honor would note that this was much broader than the claim which had afterwards been substituted, and had been made so in view of the publication of Despretz, which had been cited against it as an anticipation. He contended that this change materially narrowed the scope of the claim. Apparently the attorney had become satisfied that it was so broad he would not like to risk it, and so he had limited it to a process of building up imperfect carbons. The significance of that point was, that there was not one particle of proof that the defendant had ever utilized the process for building up imperfect carbons. All the witnesses had said it had been used "for drawing down resistance." The carbons were perfect—so perfect that the Edison Company to-day made all their carbons in this way without any treatment whatever.

The claim was for the treatment of carbon conductors *for incandescent lamps*. What force ought to be given to those last three words? The Despretz patents had been cited against Sawyer and Man. The English court had said:—"Yes, perhaps Despretz had described the same process; but it having been proved that Sawyer and Man had made a lamp, and had placed the carbon in it, had they not done something more?" Those three words must either be erased as superfious, or they must be left in and a limiting effect given to them. If the patentee had never succeeded in making an incandescent lamp, how could be be said to have made a discovery or invention in incandescent lamps? He must show that he had successfully applied it in that way, yet the evidence had shown that he had not invented a practical lamp until 1881, and meanwhile Sawyer and Man had made lamps, and Maxim had made lamps, which were perfectly successful. It was not Weston who had done it. Those three words therefore "for incandescent lamps" had placed Weston in this dilemma:—If he claimed to have made the invention when he electrically heated the carbon in oil, he had made no advance on Despretz; or if he claimed to have been first in the use of the process as applied to incandescent lamps, then he was not the inventor, because in that respect Sawyer and Man and Maxim had both preceded him. The Sawyer and Man lamp had been fully described and illustrated at the time in the *Scientific American*. The difficulty with this lamp had been twofold. First it had not a filamentary carbon, which was necessary in order to achieve commercial success, and second, it was not an all-glass lamp. It had a metal base, which was subject to leakage. Nevertheless a test made by Stowell of the Sawyer-Man lamp had shown a life of 36 hours. This had been a reduction to practice, although the lamp had broken down from too much current. Mr. Betts then read from the *Scientifi American* of March 8th, 1879, an article which, he contended, was a full disclosure of the process, two or two and half years before Weston had made his application. On the 14th of October 1878, Sawyer and Man had sold to the Electro-Dynamic Company a considerable number of patents together with the process in controversy, and the patent for the process had been assigned to the same company on February 3, 1879. What better evidence could there have been of the "sale" of the process more than two years prior to Weston's application? Mr. Betts read from the statute as to the effect of a prior sale, and asked what better evidence there could be of the "sale" of the thing patented than the fact that it had been sold. It was not material that they had not sold lamps. To manufacture and sell lamps required a large amount of capital. Newspaper articles had been published virtually offering the invention for sale. In connection with an invention of this class he knew of no better evidence that it had been "on sale".

The invention of Sawyer and Man had been embodied in a lamp so early that a patent had been granted in June, 1878. The defendants had met the obligation placed upon them by the rule of law and had shifted the burden of proof upon the complainants. Weston must now prove that he had made the invention in a fixed, positive and practical form, at an earlier date than Sawyer and Man. He would call attention to the fact that the complainant's evidence upon this point was exceedingly weak. Quimby was a patent solicitor and an expert, but there was not one word in his evidence about the making of an incandescent lamp. He had only said that the invention was useful for an incandescent lamp. Weston had never suggested to Quimby, so far as the record showed, that the invention was useful for incandescent lamps, nor had Mr. Quimby ever seen an incandescent lamp. Despretz thirty years before had done everything that Quimby saw. What was there that had advanced the sum of human knowledge one iota, in what Weston had shown Quimby? Then there was the evidence of Broadbent. Weston had not said to him that it had to do with incandescent lamps. Another significant fact:—Page, now one of the attorneys for the complainant had acted as Weston's attorney. In 1881 Page had only known him as connected with dynamo machines, arc lamps and plating apparatus. He would submit that Weston's contention was not consistent with the probabilities of the case. If Weston had ever done anything that he had regarded as of importance why should he not have communicated it to Quimby or to Page? Now they could appreciate the importance of the testimony of the witnesses which defendant had called in rebuttal. Huber, a man of great intelligence employed in the same establishment, had testified that he had seen nothing of the alleged invention nor had he seen any incandescent lamps. It was possible and even probable that he might not have seen a temporary or casual experiment, but his testimony had shown conclusively that there could have been no continuous experimentation nor diligent effort to reduce the invention to practice. The evidence had shown that Weston could not have made any invention which he himself had regarded as of any importance, for if he had done so his people all around him must have seen something of it. If he had done what he now says he had done, it was a matter too important to have been hidden under a bushel.

Again the dates were of great importance. There was no dispute as to what Sawyer and Man had done in March, 1878. It wouldn't do for Weston to say in a vague way: "I did the same thing in 1877." He must satisfy the court that there were good reasons for his saying that he had done this in 1877. A critical examination showed that he came very far from sustaining such an allegation, either by his own or by corroborative evidence.

As to the question of infringement it had not been proved that the invention had ever been used or had ever been sold by the defendant company. Mr. Betts read from Robinson on Patents, patent and other authorities, in support of the position that experimentation, merely in order to ascertain whether the process would really reduce the resistance of carbons, was not an infringement. No case of infringement had been made out.

Mr. Betts then reviewed the proof adduced in behalf of Sawyer and Man, and contended that it clearly showed that the public had been put in full possession of the invention and of full information in respect to the invention. Referring to the contention of the complainants that the exhibitions made by Sawyer and Man for purposes of display or for exploiting their electrical enterprises did not constitute the public use, Mr. Betts said that such a criticism came with peculiarly bad grace from those who sought to uphold Weston's invention. Surely Sawyer and Man had proceeded much farther than ever Weston had, for Weston had admitted that he had never made a lamp that lasted two hours. Sawyer and Man's lamp was very far from being as perfect as modern lamps, but it nevertheless was a great improvement upon its predecessors. The criticism that Sawyer and

Man's lamp never went into practical use, also came with bad grace from complainants. There had not been a particle of proof that Weston ever made a practical lamp until after it had been done by others. Maxim had commercial lamps in use in 1880. Sawyer and Man had long before that put the public in possession of the invention. The more the beauty and utility of the process became apparent, the greater became the improbability that Weston had made the invention. During the period referred to he had taken out 16 patents relating to other electrical inventions, and there was in them not one hint of a discovery of this kind. The testimony of three witnesses, his intimate associates, had been such as to preclude the possibility of any continued experimentation. It was impossible that these people should not have seen some evidence of such a discovery as complainants now claim.

Mr. Weston does not fix any date by himself or witnesses with sufficient accuracy to satisfy the courts of his priority. He has entirely failed to meet the requirements of the statute in that respect. Mr. Quimby's testimony that he saw the experiment in the basement of the "church" building, renders it important to know when Weston had his laboratory in that building. Weston fixes the date some time between the organization of the Dynamo Electric Company and his removal, and his memory, induced perhaps by his wishes, made him fix the date of his removal in 1878. The rent receipt, in the absence of any statement to the contrary, may be fairly assumed to have been for rent paid in advance, so that the date for removal cannot positively be put prior to October 1, 1878. The testimony of Quimby was very vague. He was favorable to Weston and he tried to fix the date in 1877, but was it reasonable to suppose that Quimby had any accurate recollection of the date when he saw the experiment? Would such evidence as his satisfy the obligation on the part of the complainant? He would submit that complainant had wholly failed to meet the burden of proof which had been laid upon them in this respect.

Mr. Weston had not regarded the invention as solely applicable to incandescent lamps. If he had been experimenting as a matter of scientific curiosity he had not gone beyond Despretz, for if there was any invention it must have lain in the application of the discovery to a practical purpose. Mr. Weston in 1877, had been a large manufacturer of arc light carbons. How was it that an invention useful in the very line of his business had never been so used, if he had actually made it? There was no explanation other than the explanation that Weston had never done anything at that time which he had regarded as important. Complainant must stand wholly on Weston's uncorroborated statement.

This process of treating carbons in oil or in gas evolved from oil, had never been practiced in a commercial way. The thing that was done in many incandescent lamp factories was the treating of the carbons in attenuated hydrocarbon gas, and this was found in Maxim's patent. The testimony of Vandegrift, or Shallenberger, and of Smith, all prove that carbons were always commercially treated by gas, so that it appeared that if the invention had been left where Weston has it nobody would have ever used it. It lacked the details which would render it of commercial utility. But Weston had described no apparatus for treating carbons in gas, much less in attenuated gas; on the contrary he had described a process which never had been used and was of no commercial value. Mr. Betts then commented further upon the evidence of Mr. Weston, and contended that he had wholly failed to make out a case entitling him to the favorable consideration of the court. Edison had patented a carbon filament lamp in January, 1880, and the court had declared him to be the inventor of the practical incandescent lamp. If Weston had made an incandescent lamp in 1877, why had he not been called as a witness in these important cases?

As to the question of what constituted "public use and sale," Mr. Betts said that he did not think what Maxim had done amounted to a public use and sale within two years. But as to Sawyer and Man, it was another matter. The cases which had been referred to by the other side were those in which the courts had dealt leniently with an inventor who had made his best efforts to put his invention in the market. But in the present case Sawyer and Man had certainly given to the public the fullest information in respect to their process There had been no secrecy about it. When the invention was a process, it was certain that nothing could more fully put the public in possession of it than the publication of a full description of it in the scientific journals.

Mr. Betts contended that the evidence showed conclusively that in his opinion awarding priority to Weston over Sawyer and Man, Commissioner Butterworth had overlooked the question of public use No such question had arisen as between Weston and Maxim, but he thought there was ground for holding that there had been abandonment on the part of Weston. All the time in which he had been doing nothing, other inventors had been at work, and had repeatedly described the invention in patents and in publications, and this he thought was sufficient to show that intervening rights had accrued. Despretz had certainly published what the result would be upon a carbon thread or rod heated to incandescence in a hydrocarbon atmosphere. He submitted that it made no difference what relation this had to the subsequent invention of others. The results of Despretz were in all substantial respects the results described by Weston. He certainly did not think that Weston was legally entitled to any patent for this invention.

RIGHT OF NEW STREET RAILWAYS TO USE EXISTING TRACKS.

THE Supreme Court of California, has disposed of the well-known case of the Pacific Railway Company et al. against Judge Wade of Los Angeles in an elaborate opinion. The public interest was incited by an argument for a writ of prohibition against Judge Wade to prevent him from assessing the amount of damages for and granting the right of way over the street cable road of the petitioners to the Los Angeles Consolidated Electric Railway Company. The gist of the decision is embodied in the following: "There can be no private property in a street, except the fee of the owner, which is held subject to the easement as long as the public continue to use the street as a highway. The maintenance of horse railroads and running of cars upon public streets of the city of Los Angeles for the carriage of passengers is a mere special mode of using the highway, nothing more. The right to maintain such a railroad does not exclude the public from using the street. The opinion therefore sustained the action of Judge Wade and held that the property of the petitioners is in custodia legis, and therefore the court can grant a right of way to any person or corporation and assess damages and compensation to be paid therefor, without citing or consulting the corporation, but simply upon the application of the receiver in possession of its property. The writ of prohibition against Judge Wade therefore was dismissed."

Literature.

Modern Practice of the Electric Telegraph: A Technical Handbook for Electricians, Managers and Operators. By Franklin Leonard Pope. Fourteenth edition. *New York. D. Van Nostrand Company*, 1891. *8vo. pp. xii*, 234. Price, $1.50,

THE first edition of Mr. Pope's useful and popular manual is dated 1869; a somewhat remote antiquity in electrical history. Telegraphy was then almost the sole electrical art of public significance, and some of its finer achievements were yet to come. The duplex was not yet commercially available, and the quadruplex had not arrived. In successive editions the author has kept "Modern Practice" fairly abreast with telegraphic progress, and in the case of this last edition the book is virtually rewritten and much expanded. The first edition had 128 pages; the thirteenth 160; while the book now has 234. In its original form it is familiar to most telegraphers of twenty years' standing; as recast and enlarged it well repays perusal by old acquaintances as well as by the younger men of the telegraph service. The well-ordered arrangement of numbered paragraphs and of chapters, characteristic of the first edition, has been preserved so far as the necessary introduction of new matter would permit. As before, the author has limited the scope of the handbook to the Morse signaling system, excluding type-printing, synchronous-multiplex, automatic, submarine and other methods. The duplex and quadruplex systems, now so widely employed, are amply and very lucidly described and explained; their principles of action are set forth with great clearness. A number of pages in chapter viii (Equipment of American Telegraph Lines) are given to the application of dynamos to telegraphy, a method of supplying current that has transformed the old-time battery-room of such a station as that of the Western Union Company in New York—with its endless rows and shelves of blue-stone batteries—into the semblance of a compact machine shop.

In no instance is the amplification of Mr. Pope's book more noticeable than in chapters iv, v and vi of the new edition, which treat upon the theory of electrical measurements, the laws and conditions of electrical action and of electro-magnetism. These topics, which scarcely entered the thoughts of American telegraphers a generation ago, and which were allowed but a meagre space in the early editions of "Modern Practice" (the first of which appeared but a year or two after the introduction in America in a small and tentative way of systematic line testing), are here treated with a fulness quite adequate to the requirements of those engaged in our now greatly improved telegraph service. The theoretical and technical points are perspicuously set forth in relatively simple but accurate language, the nomenclature being adapted to the best existing usage. There is also included due reference to the more recent views and speculations as to the nature of electricity. The author's cleverness in illustrating his descriptions and expositions is manifest in the many drawings and diagrams employed throughout the book. They are not only truly illustrative of the text, but in appearance are quite worthy of the fine typography and handsome make-up of the book.

A special word should be said in praise of the consideration for readers shown by an author who takes pains to provide so ample and useful an index as that given by Mr. Pope in his last edition

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED DECEMBER 15, 1891.

Alarms and Signals:—

Electric Signaling Apparatus, G. E. Miller, 464,979. Filed Apr. 3, 1891.
An electric signaling apparatus for railway trains.

Conductors, Conduits and Insulators:—

Electric Conductor, W. E. Oehrle, 464,986. Filed Sept. 14, 1891.
An insulated conductor for electric light wires.

Coupling for Electric Conductors, W. C. Preston, 465,202. Filed Apr. 27, 1891.
Consists of a short tube adapted to hold the ends of the conductors snugly, the conductor being held in place by wedges driven into an opening in said tube.

Electric Connector, W. F. Z. Desant, 465.430. Filed May 20, 1890.

Dynamos and Motors:—

Dynamo-Electric Machine, W. P. Wiemann, 465,104. Filed Dec. 30, 1890.
A dynamo comprising metallic end plates carrying rigid field-magnet cores, a magnetizable iron mass carried by the shaft extending through said field cores, the exciting coils wound on the field-magnet cores and the armature having its cores provided with pole pieces which form multiples of the polar projections on the iron mass.

Commutator Connection for Dynamo-Electric Machines, C. O. C. Billberg, 465,233. Filed Oct. 7, 1890.
Provides means for readily detaching the armature wires from their commutator strips for purposes of repair, etc.

Brush Holder for Dynamo-Electric Machines or Motors, C. O. C. Billberg, 465,234. Filed April 25, 1891.
Has for its object to maintain a proper bearing of the brush at all times upon the commutator.

Switch-Actuating Mechanism for Electric Motors, C. G. Armstrong, 465,404. Filed May 11, 1891.
Relates to construction of devices for stopping and starting electric motors.

Electric Motor Switch, E. W. Rice, Jr., 465,292. Filed Mar. 28, 1889.
Has for its object to prevent damage to the electrical apparatus from a sudden heavy flow of current.

Electric Motor, H. Groswith, Reissue 11,210. Filed Oct. 26, 1891.
An electric motor having a duplicate set of elements, a common external connection to one brush of each commutator and a pair of contacts connected respectively to the two other brushes for external connection.

Galvanic and Thermo-Electric Batteries:—

Packet or Pad for Electric Batteries, L. H. Rogers, 465,206. Filed Feb. 20, 1891.
Consists in enclosing an electrolytic chemical within an envelope of porous material.

Lamps and Appurtenances:—

Portable Electric-Lamp Holder, J. Baker and H. S. Graham, 465,039. Filed Mar. 5, 1891.
Provides means for lengthening or shortening the conducting wires of an incandescent lamp.

Measurement:—

Electrical Indicating-Instrument, E. Weston, 465,442. Filed Mar. 11, 1891.
An ampere meter in which the fixed coil is eliminated and the movable coil is closed in the annular field produced between the poles as a permanent magnet.

Metallurgical:—

Process of Extracting Copper Pyrites, T. A. Edison, 465,250. Filed Feb. 17, 1890.
Claim 1 follows:
The method of concentrating chalco-pyrites ores by eliminating magnetically any magnetic material therein, while the copper and iron pyrites are non-magnetic, and then heating the remainder to such a temperature as to render the chalco-pyrites magnetic and separating the reduced chalco-pyrites magnetically.

Magnetic Ore Separator, C. M. Ball, 465,349. Filed Dec. 11, 1890.

Medical and Surgical:—

Electric Belt, A. Erikson, 465,093. Filed June 25, 1891.

Miscellaneous:—

Means for Propelling Boats by Electricity, O. Büsser, 464,955. Filed Feb. 10, 1891.
Relates to a method of towing canal boats by means of an electric motor on the deck of the boat, acting on a stationary cable sunk in the canal, and a trolley wire strung along the bank of the canal.

Automatic Circuit-Breaker, W. R. McLain, 465,046. Filed Sept. 18, 1890.
Has for its object a method of automatically increasing the break in the circuit at the instant of the melting of the fuse wire.

Riveting by Electricity, E. E. Ries, 465,089. Filed Sept. 15, 1888.
See Patent Notes.

Feed-Water Regulator, G. W. Schilling, 465,212. Filed Jan. 27, 1891.

Method of Controlling Alternating-Current Induction, E. Thomson, 465,-078. Filed Apr. 17, 1889.
Consists in varying the angle of the magnetic axis of two coils in inductive relation to a closed magnetic circuit.

Adjustable Rheostat, F. J. Sprague and C. R. Pratt, 465,218. Filed Aug. 25, 1891.
A rheostat having a large number of contact plates in the switch by means of which the resistance is varied, said plates being so mounted as to occupy a small space and provide a rapidly-moving co-operating contact.

Electrical Sewer-Gas Indicator, J. J. Lawlef, 465,278. Filed Mar. 4, 1891.
An electric signal for sewerage systems.

Electric Fan, P. Diehl and E. H. Bennett, Jr., 465,360. Filed Apr. 4, 1891.

Electric Fan, P. Diehl and E. H. Bennett, Jr., 465,361. Filed Apr. 8, 1891.
A novel arrangement of suspended ceiling fan.

Bracket for Supporting Electric Conductors, J. A. Duggan, 465,365. Filed July 15, 1891.

Production of Insulating Coatings or Linings in Electrolytic Apparatus, L. Grabau, 465,369. Filed Aug. 9, 1887.
A melting pot having a cell surrounding an electrode, the cell being open at the bottom and having double walls forming a chamber provided with a feed and exhaust port and a discharge passage connected with the neck of the cell for the discharge of the matter.

Electric Heater, W. H. Boles, 465,428. Filed Mar. 21, 1891.

Electric Switch and Case for the Same, C. P. Chappell, 465,425. Filed Nov. 4, 1891.
Method of protecting the contact plates of switches from exposure to the weather.

Mining Machine, J. C. Werner, 465,150. Filed May 11, 1891.
Claim 1 follows:
The combination of two rotary cutter bars and an intermediate rotary clearing-worm, the cutter bars operating independently of each other and of the worm.

Railways and Appliances:—

Electric Car-Brake, E. Verstraete, 465,084. Filed Feb. 5, 1891.

Converter System for Electric Railways, M. W. Dewey, 465,359. Filed May 11, 1891.
Provides cores for the primary or road-bed coils that will form and maintain closed magnetic circuits.

Train-Signaling Apparatus, P. Synnestvedt, 465,396. Filed April 27, 1891.
An electrically operated compressed air or steam train signal.

Electric Railway, G. F. Green, 465,407. Filed Sept. 15, 1879.

Electrical Railway, G. F. Greene, 465,432. Filed May 15, 1886.
See Patent Notes this issue.

Telephones and Apparatus:—

Telephone, C. Cuttriss, 464,959. Filed July 22, 1891.
A telephone receiver without electrodes. See The Electrical Engineer Dec. 16th.

Patent Notes.

E. E. RIES' PATENT ON RIVETING BY ELECTRICITY.

On Dec. 15 a patent was issued to Mr. E. E. Ries, of Baltimore, entitled "Electric Riveting," No. 465,089. This patent describes the process in which the rivets are inserted in the holes in a cold state, which are then heated to incandescence by the passage of an electric current through the same and are maintained at incandescence during the operation of heading, by which the operation of riveting is greatly facilitated. The patent contains seven claims, of which we give the three following:

1. The method or process of riveting which consists in heating the rivet when inserted in the rivet hole or holes by the passage of an electric current through the same and then heading the rivet, substantially as described.

3. The method or process of riveting which consists in heating the rivet when inserted in the rivet hole or holes to the required degree of incandescence by the passage through the same of an electric current of suitable quantity and tension, then heading the rivet and maintaining the same in the desired state of incandescence by suitably regulating the current during the heading operation, substantially as described.

5. The method or process of riveting metal structures together, which consists in first inserting a rivet into the rivet-hole, then making electrical contact between the ends of the rivet and an anvil and the heading-die, respectively, which constitute the terminals of an electric circuit, then charging said circuit with an electric current or currents until the rivet is heated to the desired degree of incandescence, and then forcing the heading-die upon the rivet until the heading operation is completed, substantially as described.

GREEN'S ELECTRIC RAILWAY PATENTS.

Considerable interest has been manifested in the issuance of two patents to George F. Green, of Kalamazoo, Mich., as they date back to the early days of electric railroading and were the subject of prolonged interference proceedings. The patents are entitled "Electric Railway," Nos. 465,407 and 465,432, December 15, 1891, and were filed respectively September 15, 1879, and May 15, 1886.

Claim 4 of the first patent is follows:

The combination of a railway track, one or more stationary means of electric supply, electrical conductors extending from said means of electric supply along the lines of said track, and consisting wholly or in part of the rails thereof, vehicles moving along said track, rotating electro-dynamic motors fixed upon said vehicles for imparting motion thereto, and wheels supporting said vehicles upon the track, and also serving to maintain continuous electrical connection between said means of electric supply and said rotating motors, substantially as described.

Claim 3 of the second patent is as follows:

The combination of one or more sources of electric supply, a railway track, a wheeled vehicle moving upon or along said track, a conducting circuit composed wholly or in part of insulated conductors extending along the line of travel of said vehicle, one or more rotating electric motors mounted upon said vehicle for propelling the same and included in said circuit of conductors, and a circuit controller placed on said vehicle, and also included in said circuit of conductors, substantially as described.

It is claimed that Mr. Green conceived his invention long prior to the filing of his patent, and that he built and operated a small model as far back as 1874, for the purpose of exhibiting his invention to capitalists and demonstrating its practicability.

ELECTRIC SMELTING—COWLES CO. vs. PITTSBURGH REDUCTION CO.

The Cowles Electric Smelting Company has filed a bill in equity in the United States Court, Cleveland, O., against the Pittsburgh Reduction Company. The bill asks for an injunction preventing the defendant company from using certain patents for smelting ores by electric currents, claiming priority for the invention and patent. It is similar to a suit filed by the Pittsburgh Reduction Company against the Cowles Company in the Cleveland courts, and is only another chapter of the bitter fight which the two companies are waging against each other.

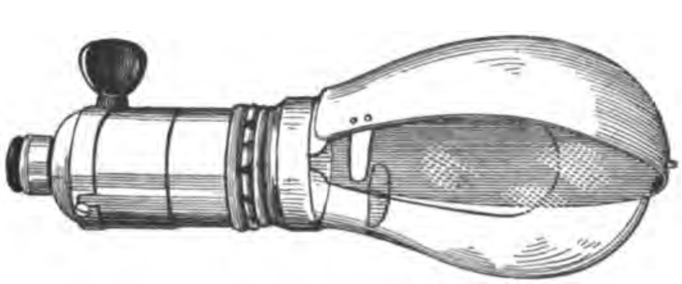
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Interest the public in your business by advertising its facts.

THE NOVELTY ELECTRIC CO.'S HALF REFLECTOR.

A NUMBER of interesting novelties and new designs in electric light fixtures and supplies have recently been brought out by the Novelty Electric Co., 50, 52, 54 North Fourth Street, Philadelphia. One of these, illustrated herewith, is their "No. 1 Half Reflector." It is a simple and efficient device, and very reasonable in price. The half-round reflector springs at once into position on the glass



NOVELTY ELECTRIC CO.'S HALF REFLECTOR.

bulb of any incandescent lamp, and a small hole at the lower end of the reflector engages with the little projection or "nipple" at the tip of the lamp. These reflectors are made in a variety of forms and admit the use of the ordinary shade at the same time.

BURTON ELECTRIC HEATERS.

THE Electric Merchandise Co., Chicago, has received this week an order for four sets of Burton electric heaters from the Aspen Mining Company, Aspen, Col., to be used in the company's motor stations. The Benson & Halcyon Heights Railroad Company, Omaha, Neb.; Edison General Electric Company, Portland, Ore.; Maschinenfabrik Oerlikon, Oerlikon bei Zurich, Switzerland; Newburyport & Amesbury Horse Railroad Company, Newburyport, Mass.; Warrensburg Electric Light Company, Warrensburg, Mo., are among the number of companies placing recent orders for heaters. The following letter has been received:

ALLENTOWN AND BETHLEHEM RAPID TRANSIT CO.
Allentown, Pa., Dec. 10, 1891.

BURTON ELECTRIC CO.,
Richmond, Va.

DEAR SIRS: Please ship eight more electric heaters with switches, being the equipment for two cars same as we had before. They are giving excellent satisfaction and are liked by the patrons of the road much better than the stoves.

Yours truly,
(Signed) A. H. HAYWARD, Sup't.

WALDO & STOUT.

THIS firm has just been organized at Bridgeport, Conn., for the purpose of embarking in the business of founders in aluminum, silicon and manganese bronze. The firm consists of Dr. Leonard E. Waldo, who is well known to the electrical profession from his work in the perfection of aluminum and silicon bronzes. Mr. Newton E. Stout will have the care of the business management.

The new foundries of the firm will be located on Railroad avenue extension, near the Wilmot & Hobbs factories, and a new road will at once be opened to that thoroughfare. The foundries will be devoted to making new alloys of copper with aluminum, silicon and manganese in the shape of bronze and brass castings.

The design of the furnaces is the Swedish patent furnace for casting wrought iron, and oil will be used as fuel. It has also been decided to erect very complete facilities for the proper testing, both chemical and physical, of the metal for engineering or other purposes. Among other things a contract has been made for the construction of a testing machine to break bars up to a tensile strength of 200,000 pounds.

The new company hope to get their first building completed by early summer. Their structures will be spread over an acre of land, and additions will be erected over the rest of the site as the work extends. The buildings will be constructed of brick, and on account of the use of oil as fuel the roof in the centre will be about fifty feet from the ground. Two acres more are held in reserve for future buildings. Mr. Erwin S. Sperry will act as superintendant of the factory.

ALEXANDER, BARNEY & CHAPIN.

THIS enterprising firm have been compelled for the third time since the establishment of their business, to enlarge their store to keep pace with their ever-increasing trade. They had to abandon the "Exchange" and tear down the offices formerly used by the purchasing agent and general sales agent, and add all that part to their store. New shelves and counters have been put up, and they have thereby not only gained a great deal of room, but the appearance of the store seems to be improved.

Among the many novelties shown at their establishment for the holiday season is a Christmas tree lighted by miniature incandescent lamps, which is attracting a great deal of attention in their window. It is seldom that a handsomer show is made during the holidays than that displayed by the A. B. C. Co. at the present time.

GAS ENGINES AND DYNAMOS FOR ISOLATED PLANTS.

ONE of the exhibits that attracted a great deal of attention at the American Institute Fair was a complete isolated plant composed of a 2 h. p. Hartig improved gas engine and a 16-light Riker low speed dynamo. The gas engine having two cylinders gets an impulse at each revolution, thus obviating any flicker in the electric light. The dynamo is compound wound and has a 10-inch pulley driven from the 44-inch fly-wheel on the gas engine. It runs at the low speed of 810 revolutions per minute, the gas engine making 185 revolutions per minute. The extremely low speed of the dynamo has also a great deal to do with the steadiness of the lights.

Below will be seen a table showing the actual amount of gas consumed per hour and cost for a specified number of lamps. This plant took the award of excellence at the fair.

Mr. Hartig does not claim the highest efficiency for his engine, but guarantees it to run at a more uniform speed than any other machine in the market.

Num. of 16 c. p. 110 volt lamps.	Volts.	Speed.	Gas consumed in cubic feet.	Cost per hour gas @ 1.25 per M.
16	110	810	80	10 cts.
12	110	820	60	7.5 cts.
8	110	830	52	6.5 "
4	110	840	44	5.5 "

Running free the engine consumed 20 cubic feet of gas.

THE UNITED STATES PORTELECTRIC CO.

ARTICLES of incorporation of the United States Portelectric Company, with a capital of $5,000,000, were forwarded from New York to West Virginia last week, the company having been organized under the laws of that State. The following are the incorporators: Thomas L. James, ex-Postmaster General; ex-Judge A. J. Dittenhoefer, John Straiton, Charles F. James, Percival Knauth, William James, John T. Williams, Colonel Henry Huss, Frank Lawton, and Whipple V. Phillips. The company controls a device for the transportation of mail and express packages at a high rate of speed, which, it has been reported, will probably be utilized by the Post Office Department. There has been an experimental plant in operation in Dorchester, Mass., for the past year. The *modus operandi* was illustrated and described in THE ELECTRICAL ENGINEER, May 27, 1891.

A CHRISTMAS TREE TWIG.

THE American Electrical Works have long had the reputation for taste and ingenuity in the little souvenirs they send their friends from time to time. The latest of their productions in this line is a pretty Christmas card, bearing a twig from their Christmas tree, associated with the usual good wishes of the season and the sentiment: "Heaven give you many, many merry days."

TO MANUFACTURE THE FIBROUS BATTERIES.

We have received information that the Fibrous dry battery and the disque Leclanché porous cup are hereafter to be manufactured exclusively by Messrs. Thompson & Robertson, 258 Broadway. This battery and cup, it will be remembered, have been manufactured for some time past by Messrs. Taylor & Walsh, of this city, whose interest the firm of Thompson & Robertson have purchased. The first-named member of this firm is the Hon. Roscoe H. Thompson, formerly of Boston, and the late treasurer of the Fibrone Manufacturing Company, of this city. Mr. J. Hart Robertson, under whose supervision the batteries will be manufactured, is a member of the New York Electric Club, and a well-known electrician, the most prominent of his inventions probably being the writing telegraph. Mr. Robertson, however, considers the fibrous battery the most promising of his inventions, and will give all his time to its manufacture at the company's factory in Bloomfield, N. J. Mr. Louis Walsh will be the manager of the sales department. Mr. Walsh is probably best known to the electrical trade through his connection with the Crosby Electric Company, of this city. The Fibrous dry battery is adapted for all open-circuit work, is small, being only 4¾ x 8 inches, and cylindrical in shape, and is said to be the only dry battery in the market that is not sealed. The company have already received many flattering testimonials in regard to this battery.

E. T. BIRDSALL, M. E.

Mr. E. T. Birdsall, of 115 Broadway, has been retained as the consulting engineer for the new Hotel Grenoble, a fine building to be put up by the well-known builder Noble. Mr. Birdsall will have charge of all the mechanical and engineering details, and will put in a fine electric light plant of about 1,200 lights. He has also been retained for the big new Municipal Building on Centre street, which will be at least two years before it is completed. Mr. Birdsall has of late had many calls of this nature upon his time.

PHILADELPHIA NOTES.

Mr. Chas. K. Westbrook, manager of the Isolated Light and Power Department of the Thomson-Houston Electric Light Co., announces the following recent sales and installations, viz.: Philadelphia and Reading Coal and Iron Co., Pottsville, Pa., 35 arc; Pencoyd Iron Co., Pencoyd, Pa., 50 arc; H. C. Hamilton & Son, Manayunk, 500 incandescent; So. Baltimore Car Works, Baltimore, Md., 85 arc; B. and O. Railroad Co., Brunswick, Md., 25 arc; Delaware Hosiery Co., Dover, Del., 250 incandescent; Penn. Supply Co., Wilkesbarre, Pa., 90 incandescent; Stinson Bros., Philadelphia, 45 arc; Cayuta Wheel Foundry Co., Sayer, Pa., 125 incandescent: Boyd, White & Co., Philadelphia, 18 arc; Shoneman & Bros., Eighth street, 6 arc; and a 75 incandescent plant for use on the boat of the Board of Police Commissioners at Baltimore, Md.

The Car Shops of the Bristol (Tenn.) Belt Line Railway Co., of which Mr. W. A. Stadelman of this city is general manager, were completely destroyed by fire last week, together with cars, motors, tools, etc., and are supposed to have been set on fire by tramps after having killed the watchman, Mr. John Overstreets, whose body was found in the ruins burned to a crisp and surrounded by four iron barrel hoops. The company has placed an order with the J. G. Brill Co. for new cars, and the road will soon be put in operation again. The road was of the Short system and had only been in operation about two months.

Vallee Bros. & Co. have this week completed the contract for wiring the Williamson Free School, which has been progressing for over a year. This firm have for several months confined themselves strictly to the electrical supply business, but the above contract was taken before the construction work was abandoned. They are agents for the Buckeye incandescent lamp, of which they have sold over ten thousand this fall. The agency for the Russell mast-arms has recently been awarded this firm.

La Roche Electric Co.—At a meeting of the board of directors of the La Roche Electric Works, last week, it was decided to build a factory for the manufacture of their electrical apparatus. A committee was appointed to select a desirable site which will be suitable for shipping facilities. This move was made in order to meet the large increase of business, which has outgrown the capacity of their present quarters.

The Century Electric Club has just been organized in this city for the advancement of its members in the electrical field, in which they are all engaged. The work will consist in reading papers, etc., discussions, and a regular review of periodicals.

"Star Electrix." The irresistible Mr. D. C. Spruance, of the Star Electrix Co., is home for the holidays from the West and reports the largest crop of orders ever known by the oldest inhabitants.

Curtis Bay, Md.—I was in error last week in stating that Mr. W. A. Stadelman had closed a contract with the Curtis Bay Railway Co. of Baltimore. It should have read Mr. W. A. Stearns, of the Edison Co.

Mr. M. S. Shapleigh, agent for the Electrical Supply Co., reports a large increase in business over last year. They have just put upon the market several new specialties which have merit.

Mr. S. Ashton Hand, vice-president of the Equitable Engineering and Construction Co., has gone to Chicago and other points West on a business trip.

Mr. C. A. Benton, of the Detroit Electric Works, was in the city last week on business, and took wing northward for New York.

WESTERN NOTES.

The Electric Appliance Company, as general Western agents of the Consolidated Electric Manufacturing Company, of Boston, are putting in a very large stock of their celebrated goods. Their sockets, wall sockets and receptacles are samples of the manufacturer's art. Their Davis arc light cut-out has been demonstrated as being a wonderfully practical article, and is used exclusively throughout Boston by the Boston Electric Light Company. Their arc light hanger boards, switches, etc., are very desirable articles at attractive prices. Their telescope switchboard plug and socket, with auxiliary transfer plug, fills a long-felt want. The Electric Appliance Company is certainly to be congratulated upon securing control of so valuable a line of specialties.

The Laclede Gas Light Co., St. Louis, will double the capacity of its incandescent electric lighting plant, and has ordered of the Pond Engineering Company, two 250 h. p. compound condensing Armington & Sims engines, with Blake pumps, and independent condensing apparatus. This work was awarded, after strong competition from all the leading high-speed engines, to the Pond Engineering Co., who will put in the foundations, and superintend the installation and starting of the plant. It is expected that one of these engines will be in operation by Jan. 1st, 1892, and the other shortly thereafter. The first engine will be belted direct to a 2,500 light alternator. The foundations will be carried to solid rock.

The Electrical Supply Co., Chicago, have converted the front end of their large store into an elegantly finished sample-room. This is separated from the sales department by a combination of handsome upright display cases and a beautifully patterned grille reaching to the high ceiling. All the woodwork is oak, finished in hard oil. The floor is of the same material, laid in mosaic figures, oiled and polished. Displayed in the cases and arranged about the room are samples of every conceivable article for electrical use. To such an extent has this been carried that the display amounts to a small exposition in itself. No visitor to Chicago should fail to see it.

The Patton Motor & Mfg. Co. are receiving inquiries from street railway men from all over the country in regard to their street railway system, recently described in The Electrical Engineer, some of which are highly interesting. They are building two complete outfits with the utmost dispatch, and which will be shipped to their respective destinations in a short time. Their car at Pullman is still running day in and day out with the same persistent regularity and refusal to break down under all the severe tests to which it has been subjected.

Mr. J. K. Pumpelly is busily employed in developing his new mechanical form of storage battery, in which he has not only made important changes from any heretofore made, but which, it is stated, does not infringe on any of the storage battery patents. His plant is located at No. 205 Springer Building, and he will shortly place these new cells on the market.

Mr. C. O. Harris, of Dallas, was in town last week looking after a number of standard articles which he will handle in Texas and the neighboring States. As a member of the late firm of Clower, Harris & Co. he built up quite a trade for supplies, and will no doubt find a ready market for the class of goods which he will offer.

The Chas. Munson Belting Co., through Mr. H. B. Morgan, have secured the order for the belting for the L. Z. Leiter Building, comprising two 48 inch, seven 10 inch, two 12 inch and one 6 inch belts. This is the largest private electric plant in the city of Chicago.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

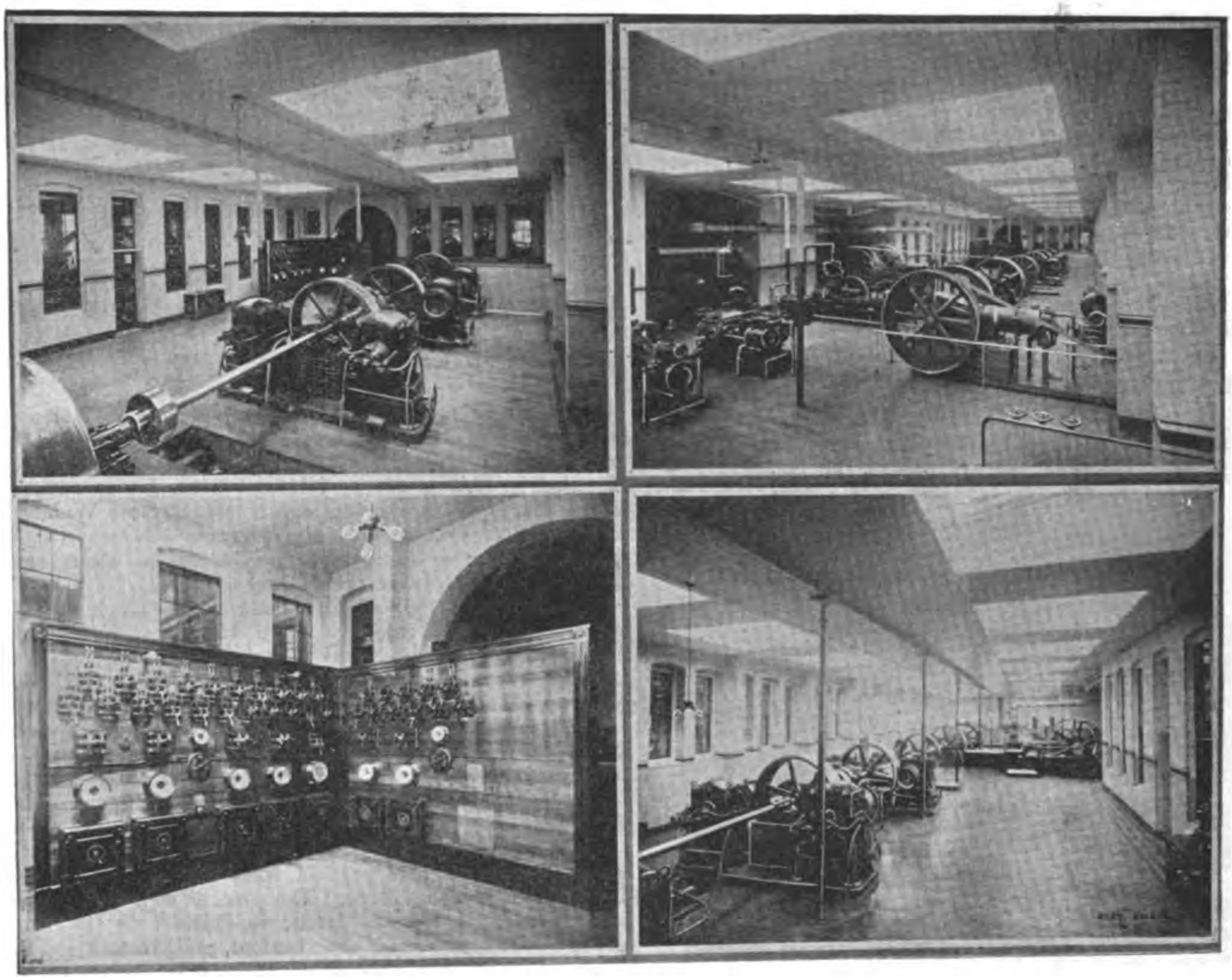
THE
Electrical Engineer.

VOL. XII. DECEMBER 30, 1891. No. 191.

LIGHTING THE WALTHAM WATCH FACTORY.

SOME three years ago the Waltham watch factory, at Waltham, Mass., after having experimented with several systems of electric lighting, concluded to put in a large isolated plant, and upon careful investigation placed the order with the Mather Electric Company, through Claflin & Kimball, their New England agents, for a plant of 2,000 lights. This plant, Figs. 1, 2, 3 and 4, was installed originally in the summer and fall of 1888, and has since been increased by the further addition of 1,250 lights dynamo capacity. They have already connected nearly 5,000 lights through the various departments of their extensive works.

The dynamos supplied by the Mather Company are of the Anthony type, whose special feature lies in the construction of the field magnets, which are constructed of laminated wrought iron of very thin plates, the magnet being stamped out of wrought iron, and thus composing a field without any joints in the entire magnetic circuit. In this way the high efficiency of the Mather dynamo is retained, together with a gain in decreased weight of the machines and slow speed of the dynamos. The dynamos have a capacity of from five to six hundred lights each, running at a speed of about eight hundred revolutions per minute.



FIGS. 1, 2, 3 AND 4.—MATHER ELECTRIC LIGHT PLANT, DRIVEN BY EVANS FRICTION SYSTEM, WALTHAM WATCH CO., WALTHAM, MASS.

The switchboard arrangements of the plant, Fig. 3, are very complete, and include a full set of instruments for each dynamo, the whole being so arranged that the dynamos are run in multiple, the dynamos being switched into circuit as the current is called for throughout the building. Each department of the building, thirty-two in number, is supplied by an entirely separate circuit from the dynamo-room, thus placing the lights of any of the departments of the building under the control of the electrician in the dynamo-room.

It was the original intention when the plant was installed to use storage batteries as an auxiliary to the dynamos, and a storage battery plant of a capacity of 500 lights was originally installed, but its use has been gradually superseded by the use of dynamos, as the batteries do not appear to be entirely suitable for the purpose for which they were used.

As will be seen from the cuts, the dynamos are driven by the Evans friction system, driving direct from the main shaft. This system gives easy control of the individual dynamos, allowing them to be started and stopped at will without the use of friction clutches. The dynamos are so arranged that they may be driven either from the main shaft from the main engine of the Corliss type, or they may be driven direct by means of a Ball compound engine of 300 h. p., which is shown in Fig. 3.

As an auxiliary to the regular dynamo plant, a small dynamo of 250 lights capacity has been installed for the purpose of furnishing light during the night for watchmen purposes and for sweeping the factory, every foot of the immense establishment being swept every night.

This plant has been very satisfactory to the Waltham Watch Company, and has reflected great credit on the work of the Mather Electric Company and its agents, Claflin & Kimball. When it is remembered what a particularly perfect service is required in the delicate work of watchmaking, it can be easily understood that a system that is satisfactory for such work must be entirely satisfactory for any of the ordinary classes of manufacturing. This we believe to be one of the best, if not the best, and largest isolated plants for manufacturing purposes run as a plant from one point. It has operated now some three years without a single breakdown or interruption of service of any kind.

THE WADDELL-ENTZ ELECTRIC MOTORS AND DYNAMOS.

There was a time, not many years ago, when the designing of dynamos and motors was in the hands of that class known by the generic term of "inventor," whose chief aim seemed to lie in the direction of constructing machines not with the view, particularly, of obtaining the highest results, but of working out a design which should differ as far as possible from that of all other existing machines. This practice has fortunately gone very largely out of fashion, and in its place we find the efforts of designers bent in the direction of constructing machines which shall be not only of very high electrical efficiency, but in which the design is such that the machine can be produced with the least possible cost. A good example of this modern tendency is to be found in the design adopted in the machines now being constructed by the Waddell-Entz Electric Co., of this city, and our readers will be interested in the description of the means which have been employed to effect the desired purpose.

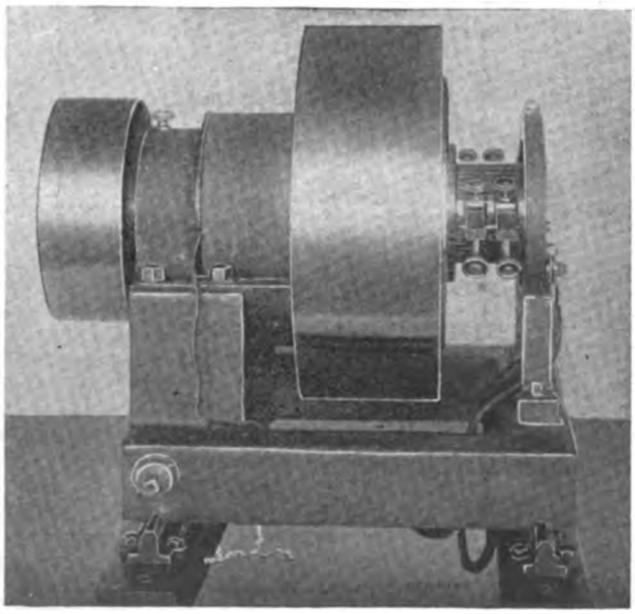


Fig. 1.—The Waddell-Entz Dynamo.

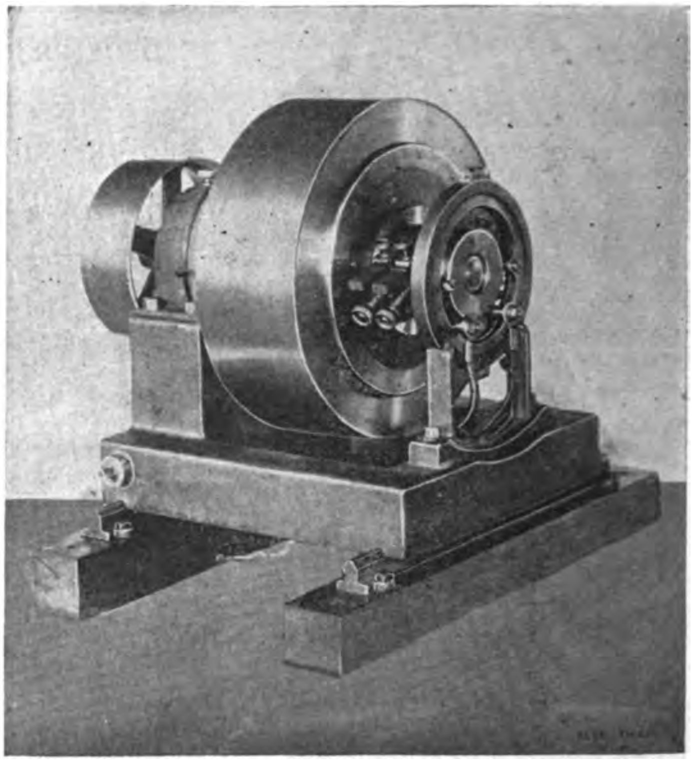


Fig. 2.—The Waddell-Entz Dynamo.

The machine which we illustrate in the accompanying engravings has a capacity of 2 kilowatts, and in its design Messrs. Waddell and Entz have had in mind constantly, first, the securing of high electrical efficiency with a mechanical construction such that the parts should be subject to the least manipulation and machine work. It was for these reasons that the type of field and armature shown was adopted. As will be noted, the field magnets are energized by a single coil wound upon a core which has a projecting horn which forms the upper pole piece. This core is let into a hub, which has a low projecting flange running parallel with the core, and which forms the lower pole-piece. The core, as well as the outside surface of the pole itself, is finished on the same mandrel, and is bored and bushed, and turned at the end. The energizing coil is slipped on to the core, which is held in place securely by two screws which prevent it from turning and at the same time from slipping in and out. The core is of malleable iron, and, as already stated, is bushed, and forms the bearing for the armature shaft. In order to provide for ample oiling the magnet is cored, thus providing an oil chamber; at each end of this core a ring passes over the shaft and dips down into the oil below, so that as the shaft revolves a continual supply of oil is fed to the bearing. As a result, the machine requires no attention in this regard for weeks at a time. In the larger machines having four or more poles a second bearing is provided, but in the two-pole machines, as stated above, the armature is entirely supported by a single long bearing passing through the centre of the magnet core.

The construction of the armature adopted in this machine has been very carefully worked out, and a somewhat striking feature of the machine is the fact that no wire whatever is visible, the armature being inclosed in a brass cover. The armature is built up of soft iron rings stamped in a press, and one of its principal characteristics lies in the fact that it is built up and held in position without the employment of bolt holes passing through the armature. By this design the full section of the iron is utilized, which is particularly desirable in multipolar machines. The rings, insulated by paper, are perfectly smooth, and require no turning in the lathe after they come from the stamping press. For the purpose of building up into an armature they are put into a press between two outside rings of brass, and are then screwed up under pressure.

spider is bolted to the armature ring by means of the same bolts which serve to bind the armature plates together, and the brass cover is then slipped over the armature and held in place by screws. By the employment of the bolts on the outside of the armature not only is the reduction of the magnetic circuit obviated, but, in addition, the insulation of the plates from one another is not destroyed, as has frequently been proved to be the case of the bolts passing through, and which therefore require to be insulated and thus serve to still further increase the size of the hole and thus reduce the iron section.

As the pole-pieces are situated entirely on the inside of the ring, all trouble due to shifting of the wires by centrifugal force is avoided, as the revolution of the armature merely tends to keep the inside of the wire more firmly in place; besides, the action of the magnetic lines is such as to make the wire hug the armature more closely.

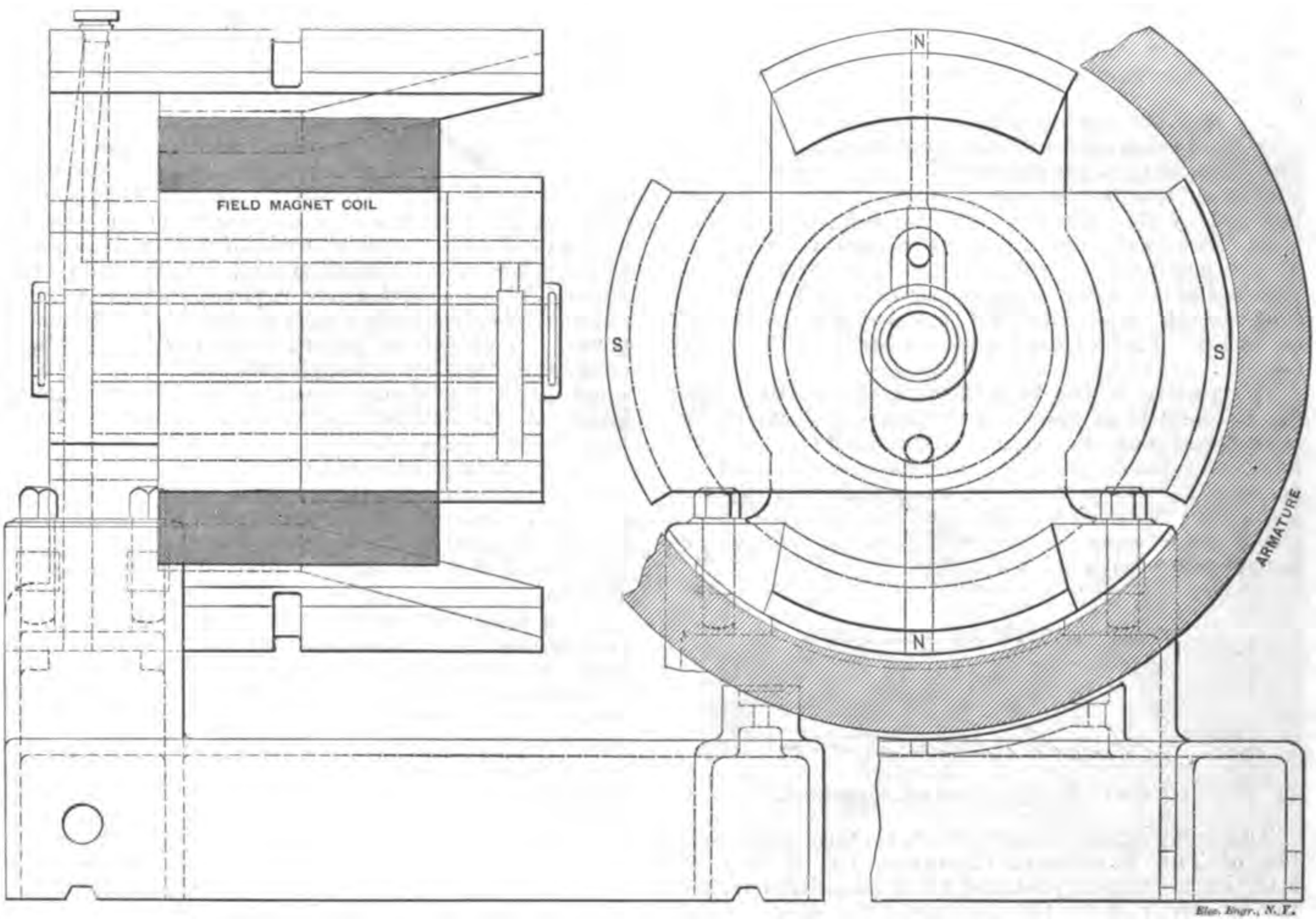


FIG. 3.—MAGNETIC FRAME OF WADDELL-ENTZ 4-POLE MACHINE.

The outer brass rings are then clamped together by a series of bolts spaced evenly around the armature and screwed up by nuts while the plates are under pressure, so that when the pressure is released the armature comes out as a solid ring.

The bolts encircling the armature are placed on the outside circumference, leaving the inner entirely smooth, and are of small diameter, being so spaced that they form grooves for the winding. They thus afford a positive driving and take the place of teeth without, however, introducing disturbing reactions. They also avoid the slotting of the armature and thus can be stamped out with a smooth, round die. The armature is therefore practically ready to wind as soon as it comes out of the press, so that the least possible time is lost. While this operation is going on, the commutator is being built up upon the spider through the center of which passes the shaft. When complete, the

In the two-kilowatt machine illustrated, the brushes are held by a stand encircling the end of the commutator. Each pair of brushes is mounted on a separate ring, these rings being insulated from each and held in position in the frame. The machine is so designed that the brushes, once set, require no shifting, the machine being sparkless at all loads.

The machine, it will be noted, is mounted on a pair of rails, and for the purpose of tightening the belt a screw passes through a threaded eye cast into one of the rails. By this means, while being shifted to and fro, it is at the same time positively held in position and its stability thus increased. The machine work required in the building up of these dynamos, it will thus be noticed, consists almost exclusively of boring and turning, the only planing necessary being that required for the rail grooves. On account of the design adopted, it will be seen that each part of the machine can be separately constructed, the armature being independent of the commutator and spider, and each of the magnetic parts also is capable of separate finishing. The result is that the machine can be constructed in the least possible time as no one part need be delayed while another is being finished, a most desirable feature in the rapid filling of orders.

The design of the frame of the four-pole machine is illustrated in Fig. 3. Here, it will be seen, a single energizing coil is also employed, but an outer bearing is added to give stability to the armature.

These machines are built in sizes varying from 2 to 100 kilowatts. In the two-kilowatt machine the armature resistance, warm, is .0295 ohm, and it is wound with two No. 15 B. & S. wires. The field resistance, including the regulating box, is 100 ohms. This gives a drop of 5.04 volts in the armature, and an efficiency of 90 per cent. at 1,100 revolutions of the armature. The floor space occupied by this machine is remarkably small, the dimensions of the machine being as follows: Length, 18¼ inches, outside of pulley; width, 19 inches, outside of rails; height, 18 inches.

The 25 K. W. machine has six poles, an armature resistance of .015 ohm, and a field magnet resistance of 30 ohms. The diameter of the armature is 39¼ inches and it runs at a speed of 390 revolutions per minute. The floor space occupied by this machine is 46½ × 46½, and 48 inches high. The 50 K. W. machine has 8 poles and the 100 K. W. 10 poles; the latter running at 200 revolutions per minute and occupying a floor space of 78x82 inches, and standing 82½ inches high, with a diameter of armature of 68 inches. Each of these machines has but a single magnet coil.

The factory of the Waddell-Entz Co. at Bridgeport, Conn., where these machines are now being constructed, is equipped with the most modern machinery, and it is safe to say that by their use, in connection with the simplicity of the design employed, the production of dynamos and motors has been brought down to a degree of simplicity and cheapness which would hardly have been believed possible but a short while ago.

ELECTRICITY AT THE PLOW.

BY

A. A. Denton

Of the U. S. Department of Agriculture.

The following statements are not, perhaps, in the regular line of The Electrical Engineer, but if they turn attention to practical problems which immediately concern the prosperity of the Great Plains of the West, they will be well worth space in its columns.

In the States which occupy the Great Plains there is an immense area, nearly level, free from stones, trees, or other impediments to cultivation of the soil by power machines. The sole power now available for the cultivation of this almost boundless farm, is animal power. Western farmers wisely, perhaps, certainly necessarily, discard hand implements, so far as possible, and depend almost wholly upon animal power machines in the production of immense crops of grain. The use of animal power always has been, and always will be subject to limitations. Manufactures made comparatively little improvement until the adoption of efficient prime motors. Disconnect engines and motors and turn the shafting of a manufactory by flexion of muscle, and see how essential to modern manufactures are modern motors. So long as commerce was dependent upon galley slaves or upon slow-moving caravans, so long it was necessarily limited. Agriculture is now where Manufactures and Commerce were before the adoption of efficient motors, and like them it will make wonderful progress when it substitutes tireless motors for animal power.

As a consequence of this limitation of power in agriculture, a very large part of the Great West lies fallow and unproductive. The annual prairie fires harvest the natural crop of grass. The useless smoke of these prairie fires should take the form of food supply for the hungry millions of the earth. They should be replaced by wheat fields of vast extent. The rapid extension of agriculture in the Great West is simply a matter of the application of efficient motors equal to the demand of agricultural work in that section.

There has been very great improvement in agricultural work in the last half century, and all of that improvement is due to the substitution of animal power, or of steam power, for manual labor. The application of animal power to the reaper performs the labor of 30 men. The application of power to the threshing machine saves two-thirds of the manual labor formerly required. The application of steam power in the locomotive renders the carriage of farm products easy. It is in consequence of these comparatively recent applications of power that the Western States have developed production to a degree which would have been impossible in previous centuries. And it is in this line, the adoption of efficient motors, that agriculture will make still more wonderful progress. Only a beginning has yet been made in the application of power to agricultural work. Agriculture is inferior to manufacture, as its prime motor, animal power, is inferior to steam power. Western agriculture requires to take a step in advance, by substituting a more powerful motor for animal power. In agriculture proper, that is, in the growing of crops, invention has accomplished but little, and that is simply in the line of substituting animal power for manual labor. At the dawn of civilization, the barbarian farmer, with his rude plow drawn by bullocks, was not so greatly inferior in accomplishment to the Western farmer with his steel plow drawn by his overworked team. In the saving of crops, after they are produced, invention has done much. We harvest 20 acres of grain per day, we thresh 20 acres per day, we carry the grain 500 miles per day to market, but by the inefficiency of its motive power the plow is limited to two acres per day. Our reapers can reap more grain, our threshers can thresh more grain, our locomotives can pull longer trains, loaded with grain, but Western agriculture is held back by the inability of animal motors to plow faster and deeper and more cheaply. It is thwarted, in a measure, by plowing done out of season, done badly, and expensively. It is limited by the amount of work which can be got out of its tired motors.

There is cruelty to animals in our Western system of agriculture. With immense work and with feeble motors the result is the destruction of the motor. With limitless power in the earth, in the air, and in the sea, we drive helpless animal motors to death. Invention has placed the burden of agriculture upon them, and they are broken down when they should be in their prime.

It appears useless to exploit steam as a motor in agriculture. The steam engine has apparently been improved nearly to its limit. The difficulties in the way of applying it to agricultural work appear to be inherent and unavoidable. On foundation or on rails it is indeed a giant; when it touches earth it is powerless.

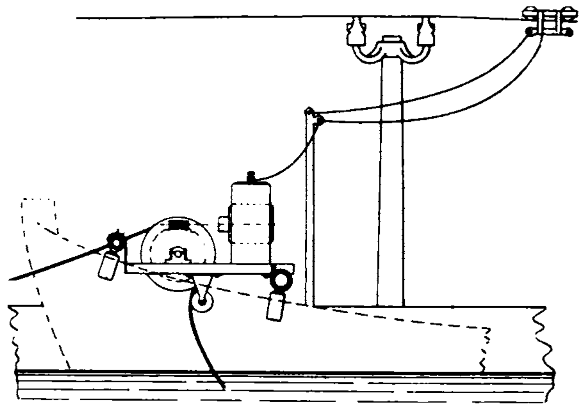
It appears otherwise with the electric motor. It is simple, its few wearing parts can be protected from dust, it has ample power, it has not excessive weight, it carries neither fuel nor water.

In its simplest expression, the problem is the dragging a plow, a harrow, a seeding machine, a reaper or a wagon loaded with grain, half a mile, in a straight line, reversing, and dragging it back again, simply passing to and fro, until the entire field is worked.

In the many applications of electrical work, this, the most important and the extensive application of all appears to have been entirely overlooked. This shall lighten human labor, shall relieve suffering animals, shall increase production, decrease cost and cheapen food. We will wonder, a few years hence, how men produced food for all mankind by use of the whip. And we will point to the old-fashioned plowman, urging his tired and slow-moving team, as we point to the old-fashioned man who swings the old-fashioned cradle in grain. There is urgent demand in agriculture for electrical engineering.

TOWING CANAL BOATS BY ELECTRICITY.

The fact that a vast amount of freight is still transported by means of canal boats, and that these boats are



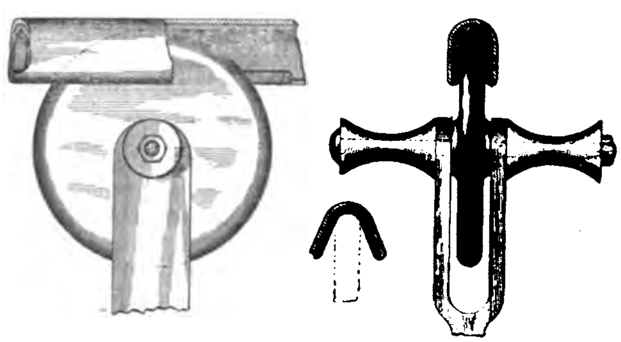
Towing Canal Boats by Electricity.

still drawn by horses or mules, as in the days of Rameses or Tiglathpileser, lends especial interest to a recent invention of a German engineer, Mr. Otto Büsser which is well illustrated in the accompanying drawing. As will be seen, a stationary cable is laid at the bottom of the canal and is grasped by a set of sheaves on the deck of the boat, actuated by an electric motor. The current is supplied to the latter by means of trolley wires strung along the bank, the trolley making contact on the upper side of the wires and being towed along by the flexible conductors.

A peculiar feature of this arrangement is that the whole installation is portable, and is readily fixed to the gunwales of the boat as it enters the canal, and removed at the further end. This is accomplished by fastening the motor upon a bed-plate resting upon adjustable cross-rods at whose ends are pivoted vertically clamps which fit over the gunwales and are firmly held by set-screws.

THE SARGENT INSULATED TROLLEY WIRE.

In order to obviate the necessity of guard wires in overhead electric railway construction, and to remove, at the



Figs. 1 and 2.—Sargent's Insulated Trolley Wire.

the same time, a serious source of trouble in the management of such roads, Mr. Charles E. Sargent, of Chicago, has devised the novel form of trolley wire shown in the accompanying illustrations.

As will be seen, the conductor is ∩-shaped in section, and has its upper and outer side covered with insulation, the trolley wheel being without flanges, and traveling in the uninsulated groove formed by the inside of the ∩.

The two spools of insulating material seen on opposite sides of the wheel, Fig. 2, are for the purpose of striking against the lower surface of the wire and limiting the upward movement of the free end of the trolley-arm when the trolley-wheel misses the wire.

This form of wire, has of course, considerably more rigidity than the ordinary cylindrical wire in use now, but this, it is claimed, is not sufficient to prevent its being coiled readily on rollers for transportion.

THE MOORE TROLLEY AND AUTOMATIC DEVICE FOR CONDUIT RAILWAY WORK.

BY

D. McFarlan Moore

The partial success of a number of conduit electric railways in Europe has led many to believe that the solution of the electric railway problem lies in some form of

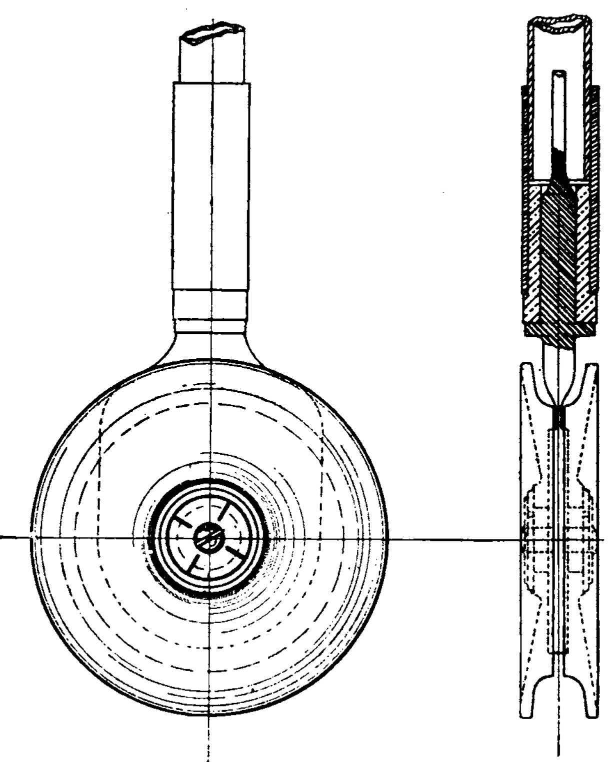


Fig. 1.—Moore's Conduit Trolley.

the conduit system, and particularly as the use of the overhead wire is absolutely prohibited in many large cities, such as New York and Chicago. It seems also to be well recognized that in the ideal conduit system of electric railways the trolley or contact device should be permanently attached to the motor truck, and not be detachable from it.

This result can be successfully accomplished by the use of the trolley illustrated in the engraving, Fig. 1. It is designed to be lifted from the conduit at any point on the line, and as such is the narrowest trolley that can possibly be constructed, being a trolley wheel without a yoke. As each half of the trolley has its own bearing, it may be termed a split trolley wheel. Each half of the wheel runs independently of the other half; this is advantageous in rounding curves, as it makes the contact more perfect. The principle involved in this trolley is by no means confined to railway work, as it can be applied in many instances for moving contacts in general, and especially when large working conductors are used. Its construction is simple and cheap, and its various parts can easily be replaced. Its design is such that the slot in the conduit need be only three-quarters of an inch, or less, in width.

The application of electric power for operating tramcars, transfer tables, etc., in machine shops, foundries, mills and manufacturing establishments of all kinds is rapidly becoming an important part of electrical engineering railway work. In every case it is desirable, and in many cases absolutely necessary, that the trolley wire or working conductor should be beneath the ground or floor of the shop. This is necessitated in many instances by the use of traveling cranes, which preclude the possibility of employing an overhead trolley wire. In many large manufacturing establishments it is desirable also to have the tramway run not only inside of the various buildings, but also from building to building, and if the buildings are widely separated it may be required to connect them with the overhead system.

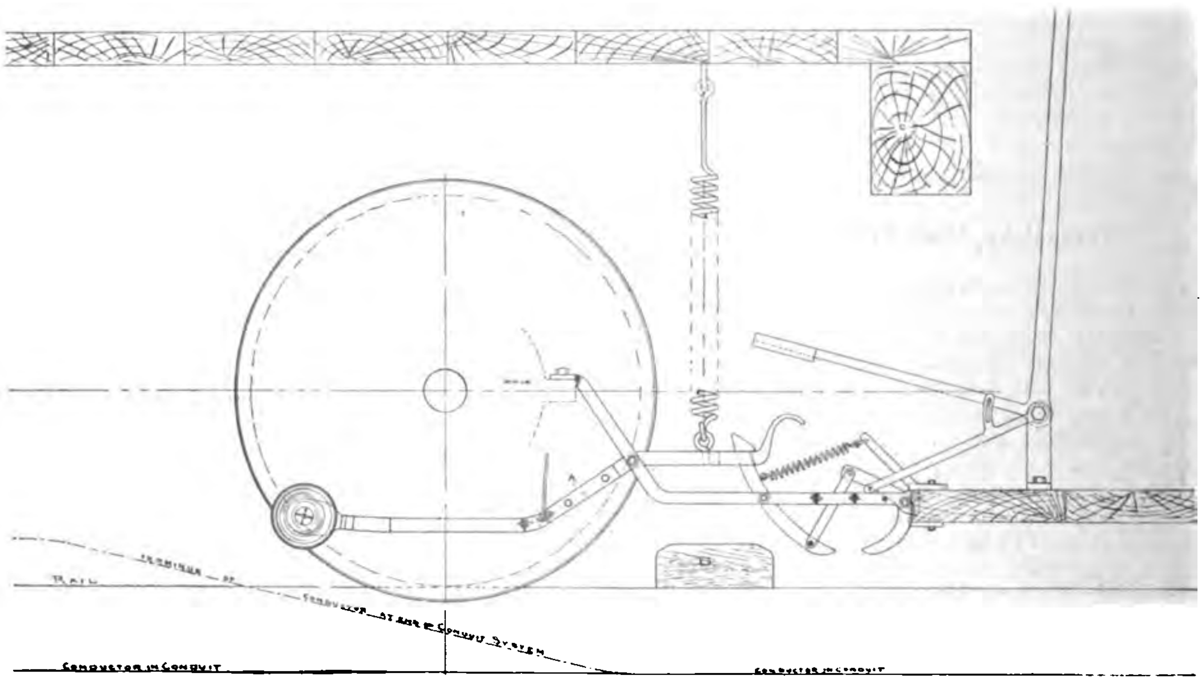


Fig. 2.—The Moore Automatic Device for Railway Conduits.

Fig. 2 shows an automatic arrangement for raising and lowering the trolley when necessary to change from the underground to the overhead system, and vice versa. As will be readily seen the levers are operated automatically by means of the block, B, placed in the centre of the track. The trolley is raised from the conduit by simply placing the conduit conductor on an incline, the inclined portion of course being "dead." The cheapest and best forms of conductors for conduit work when using this trolley are iron or copper bars or angle iron. The lever, C, is provided only as a positive arrangement in case the automatic device should not act, owing to the removal of a block or for some other like reason. In case a return conductor is required the main trolley lever can be forked at the point marked A, so that two trolleys can run in two conduit slots separated by about six inches.

L'Industrie Electrique, a new Parsian electrical journal, will be published from the beginning the year under the able editorship of M. E. Hospitalier.

HOW TO INVENT THE SUCCESSFUL COMPETING TELEPHONE.

BY

Edward P. Thompson

A point of valuable knowledge, among other matters, with which the would-be inventor of the successful competing telephone should be equipped, is the gist of each class of telephone, which has been invented thus far. It is almost safe to say that the successful competing transmitter will consist of some slight improvement over some existing improvement or original invention. The most powerful example, which presents itself, is the very transmitter which suggests the present problem. Although the result is far inferior, the Reis transmitter of musical sounds is exactly like the Berliner transmitter, except to those who know the gist of both. In each case two terminals of an electric circuit are normally in contact. However, when the device is in operation, the contacts separate in the one, and remain together in the other with variable pressure. It is found that all the telephones at present known are divisible into a comparatively few classes, and that a short sentence will give the pith of each. They are treated, not in any chronological order, but in the order in which they naturally appear in the mind. Even if read, not for the purpose of assisting in inventing, the classified knowledge may be useful in other ways.

The State of the Art.—In one or more transmitters at present known, electrical undulations, corresponding to air vibrations, are produced by causing the mechanical energy of the condensations and rarefactions of the air.

To vibrate a diaphragm of iron before the poles of a magnet.

To vibrate the diaphragm of iron before the poles of a magnet in which the core is partly or wholly of steel.

To vibrate a steel diaphragm before the poles of a magnet with or without a core.

To vibrate a magnet before the poles of a second magnet.

To vibrate an iron sheet *between* the poles of a magnet.

To vary the temperature of a heated conductor of very small diameter, such as a platinum wire, the condensations and rarefactions of the air causing the alternate heating and cooling of the conductor (comparatively) whereby its resistance is similarly varied.

To vary the temperature upon the face of a thermopile, the condensations and rarefactions of the air causing an alternate heating and cooling of the thermopile, whereby electrical undulations are produced (theoretical).

To vary the length of a continual spark between the two electrodes, the electromotive force of the current being sufficient to maintain the spark (theoretical).

To vary the linear resistance of a ligature, such as a carbon filament, the air vibrations causing a conducting liquid to rise and fall alternately along a part of the length of the wire.

Same as above, the air vibrations causing a second conductor to intermittently touch or short circuit variable portions of the first conductor.

To vary the amount of light falling upon a conductor, such as selenium, which is sensitive to light in such a manner, that for variable light, its resistance varies.

Same, except that a substance sensitive to heat rays is employed.

To vibrate a card board, supporting iron filings, before the poles of a magnet.

To circularly vibrate the armature of a minute dynamo, before the poles of the field magnet.

To vary the pressure existing between the two carbon or metallic or conducting liquid electrodes normally and abnormally in contact with each other.

Same, the number of the electrodes of one or both polarities, being increased.

Same, one of the electrodes, when metallic or carbon, being pulverized.

Same, in which one of the electrodes is a valve, loosely located upon the end of a tube which is the other electrode.

To vary the pressure upon the plates of a voltaic pile, an alternate increase and decrease of distance between the plates causing variable amounts of current generated.

To vary the shape of a globule of mercury balanced in a conducting liquid, the vibrations of the better conductor, mercury, varying the resistance of the circuit.

To vary the static charge of condenser plates, whereby the electric current of the line becomes varied as to its electromotive force.

Conditions of the Problem.—It is needless to mention that these are very severe. The transmitter must possess novelty over all those at present known, and further, it must be equal and if possible, superior, to the carbon transmitter. It should be applicable to long lines, and in such a manner that the receiver will give forth the words clearly and loud enough to be heard intelligently. It should serve the test of transmitting the ticks of a watch and whispering, when two or three feet away from itself not simply over a small distance, but for a mile or so. For a short distances it should transmit the sound of heavy breathing. It is assumed that a good Bell receiver is used, such as that on which the patent expires in March, 1893. One of the difficulties, in order to be as profitable, commercially as the carbon transmitter, is the cost of construction. The latter consists substantially of two pieces of compressed carbon powder, a diaphragm of tin-type metal, and the frame, the carbons being supported in a relatively yielding position, and means of adjustment being provided. It is one of the cheapest electrical devices manufacturable.

ELECTRIC LOCOMOTIVES IN FRANCE.

The French Northern Company will shortly make some trials with an electric locomotive between Paris and St. Denis, and afterwards, if these prove satisfactory, between Paris and Calais. On falling gradients the *vis viva* of the train will be utilized for recharging the accumulators.

IS IT NECESSARY TO BOND ELECTRIC RAILWAY TRACKS?

In an article on the Gibbon duplex rail that was published in The Electrical Engineer of Oct. 29, 1890, the suggestion was made editorially that with such a continuous rail it should no longer be necessary to "bond" electric railway tracks. Rail bonds are at present a necessary evil, and while many improvements have been made in them, very few electric railway managers would care to go on using them if they could be dispensed with. Not only do they often introduce seriously wasteful resistance, but very frequently they disappear altogether, leaving merely a stain in the earth to signify that they once were there, very much as Dickens represented one of his characters to have vanished, leaving only a grease spot behind. It therefore occurred to us that the Gibbon rail, altogether aside from its qualities as a rail, might offer an effective remedy for the "bonding" trouble. Learning recently that a section of this track had been furnished to the Brooklyn street railway companies, we obtained permission for a test of it by Mr. Townsend Wolcott, who has now submitted the following report to us under date of December 24:

> I have examined, according to your request, the section of track furnished to the Atlantic Avenue Railway Co., Atlantic and Third Avenues, Brooklyn, by the Duplex Street Railway Track Company.
>
> The track is so keyed together for the purpose of securing mechanical continuity and strength, that electrical continuity is at the same time secured, thus rendering the track a good electrical return for trolley or conduit roads, without any other bonding than that which is a part of the system and which does not involve extra expense as do the ordinary methods of bonding.
>
> I made a bridge test of the above-mentioned section and found the resistance too small to give an indication on the bridge, although the latter showed .001 ohm very plainly. The test current had to pass through two keys and around one complete joint.
>
> I think this track when properly laid, will be found practically equal to a continuous rail both mechanically and electrically.
>
> Townsend Wolcott.

This seems to confirm our opinion very thoroughly, and we print his report as one of interest to our readers in the railway field. We have now suggested to Mr. Wolcott the desirability of a direct comparison, electrically, between this track and that of some electric road with "bonded" tracks lately finished. Such a comparison has now been undertaken, and we hope soon to give the results. In the meantime, we shall be glad to hear from any of our readers on this important subject.

INFLUENCE OF STEAM ON PERMANENT MAGNETS.

The influence of steam on magnets is the subject of an interesting note in the *Schweizerische Bauzeitung* in which reference is made to the researches of Strouhal and Barus. These have shown that with long-continued heating in steam, magnets lose from 28 to 67 per cent. of their power. If, after this, the magnets are remagnetized and again exposed to the action of steam, only a very slight loss of magnetic power is found to take place. The experiments which have been made would seem to warrant the conclusion also that after such treatment a magnet is less liable to deterioration from mechanical vibration as well as heat. In one of the experiments, a short magnet was boiled in water for four hours. It was then magnetized and held in an atmosphere of steam for two hours more, after which its magnetic moment was measured. It was then subjected to 50 blows from a piece of wood, both transversely and longitudinally. Again measuring its magnetic moment, showed a loss of $\frac{1}{800}$, and on repeating the hammering with the wooden bar the loss was $\frac{1}{400}$ of the original moment. In view of all this, repeated steaming and magnetizing is recommended as a good means of securing permanent magnetism in pieces of hard steel.

ELECTRIC ICE-HARVESTING MACHINERY.

BY

F. E. Kinsman.

In 1805 Mr. Frederick Tudor, of Boston, began the exportation of ice. In 1832 the entire quantity exported was less than 5,000 tons, all of which was taken from a pond in Cambridge, Mass. In 1846 there were 65,000 tons exported; in 1856 it reached 146,000 tons, while in 1875 the shipment of ice to southern cities and ports exceeded 1,000,000 tons. To-day we are shipping large quantities to European ports in addition to an extensive Southern trade; even in view of the fact that Norway is supplying large quantities, we are able to sell ice in Great Britain, in competition with nearby countries, and this notwithstanding the fact that our method of cutting and harvesting has not been materially altered since Mr. Tudor's first effort in 1805. Many efforts had been made to improve the process of cutting and handling ice, but with the exception of the improved form of the old-fashioned ice-plow, drawn by horses. which requires two men each, one to lead the horse, and the other to guide the plow—and the method of hoisting the ice into the storage building by steam power, practically nothing had been accomplished, until the year 1890, when the writer brought out his self propelling electrical ice-cutting machine, which can be made to do the work of any number of horses, and the necessary detail of laborers to manage them.

No branch of industry of any importance, has suffered such neglect, and at the same time assumed such enormous commercial importance as the ice business of the United States. Its importance to our every-day life, was clearly brought out by the great outcry that was raised by the press during the winter of 1889-1890, when it was found that there was likely to be an ice famine, and its domestic and sanitary value was even more clearly demonstrated by the comparatively high prices which the public were compelled to pay for that which was consumed, most of which was brought from the extreme northern sections of the United States. The difficulties of securing the crop from such points, and the high price consequent thereon, greatly stimulated the introduction of artificial ice-making apparatus. This was done to such an extent that, naturally, ice men began to realize the important character of their new competitor and to look about them for means of reducing the cost of harvesting and handling their product. They found that the principal points to be considered were, first, the matter of reducing first cost; second, the securing of locations where an unfailing supply could be had near the market. The first item, that of first cost is largely made up of the price paid for labor and teams. Owing to the knowledge on the part of the workmen of the fact that frequently but few days were vouchsafed the companies in which to secure their crop, they could practically place their own figures upon their services and for the use of their teams, where such were required.

Another item of grave importance, in the aggregate, was the loss of horses by drowning (one company is reported to have lost 27 in the winter of 1891 from this cause); another source of loss is from influenza contracted by exposure on the ice fields. The drawing of an ice plow being an absolutely dead weight, requires a constant drag, and those acquainted with the business well know how quickly a horse begins to perspire, even in the coldest weather. It only requires a stop of a few minutes for rest, or any other cause, to give them a severe chill and cold, which is likely to develop into lung fever or pulmonary diseases, which is said to be one of the largest indirect items of cost in the harvesting of natural ice.

Another important item, is the trimming of irregularly shaped cakes of ice, when they reach the foot of the hoisting apparatus. This irregularity is due to the fact that the plow now in use cuts but from three to four inches the first trip, and from two to three inches the second trip, and approximately two inches the third trip, a total of from six to nine inches, leaving, with 18 inch ice, from one-half to two-thirds to be split, and any irregularity in splitting has to be corrected before it is passed into the storage house. It has also been found that the old method of packing ice with layers of straw or sawdust between each tier, was troublesome and expensive. They therefore adopted the method of corrugating the cakes of ice, as they passed into the ice-house by a special attachment connected with the hoisting apparatus. This permitted the putting of the corrugated faces together, which answered the same purpose as straw or sawdust, namely, prevented the cakes from freezing together in a solid mass. This corrugating and trimming of the cakes of ice left around large houses a troublesome accumulation of refuse ice, the removal of which was not an insignificant item of cost. These matters are however to a certain extent governed by circumstances within the control of the companies themselves.

The second point, however, that of an unfailing supply, is one over which the companies have had no control in the past, and one in which the writer proposes to come to their assistance, by the use of apparatus with which they will in a measure be able to overcome the unfavorable condition of the season, and to harvest ice that is thinner than it is possible to harvest with horses.

It is well known that the temperature of the water under the ice is higher by from six to eight degrees than the ice. As it is impractical to remove the snows which fall upon the ice before it is thick enough to bear a horse, the thickness of the ice is somewhat reduced by having a comparatively warm body of water beneath it and a protecting blanket of snow upon it, which would not be the case if the snow could be economically removed as fast as it falls, thus exposing it to the lowest possible temperature.

This can be accomplished by the electrical self-propelling snow-removing apparatus, devised by the writer, with but comparatively little trouble and expense. The planing and cleaning machine is equipped with a scooping chamber, which can be dumped when once filled or upon approaching the shore limit of the ice field, while the planers can be raised or lowered sufficiently to remove the unevenness of the upper surface caused by rough and windy weather, when the ice first begins to make. These planers are detatchable at will; they are furnished either rotary on a plane with the ice, or revolving before the saws. The cutter or groover is so constructed as to admit of the easy adjustment of the knives for cutting between the thickness of ice, where, if it is desired, the shafts upon which the knives are mounted in gangs are also supplied with corrugators which corrugate the upper surface of the ice as it is cut. This corrugating upon the field is a decided improvement over doing the work at the ice-house, as all the refuse ice made or produced by cutting and corrugating is floated off on the water when the cakes are split from the main body, and become submerged in the water. Here it is well to mention the fact that, on account of the greater depth to which the main grooves are cut which divide the cakes, a much more even side is obtained, as the shorter the splitting space, the less divergence from a true line.

The electric ice-cutting machine designed by the writer is shown in side and end elevation respectively, in the accompanying engravings, Figs. 1 and 2. The illustrations are so clear as hardly to require a detailed explanaiion. The cutters are driven direct by the armature which has an elongated shaft upon which the cutters are mounted, thus obviating the necessity of using belting or gearing. The depth of the groove to be cut can be regulated by a hand-wheel under the control of the attendant, the cutters being raised by a worm-and-tooth segment. The same shaft that carries the cutters is provide with two worms which, acting through shafts and bevel gears, propel the wheels upon which the machine is mounted. By this means an exact ratio is obtained between the travel of the machine and the speed of the cutters. The direction of the machine is controlled by the hand-wheel and sprocket chain passing around the pivot of the rear wheel; but the machine may also be guided by a special "guide" running in the groove last cut.

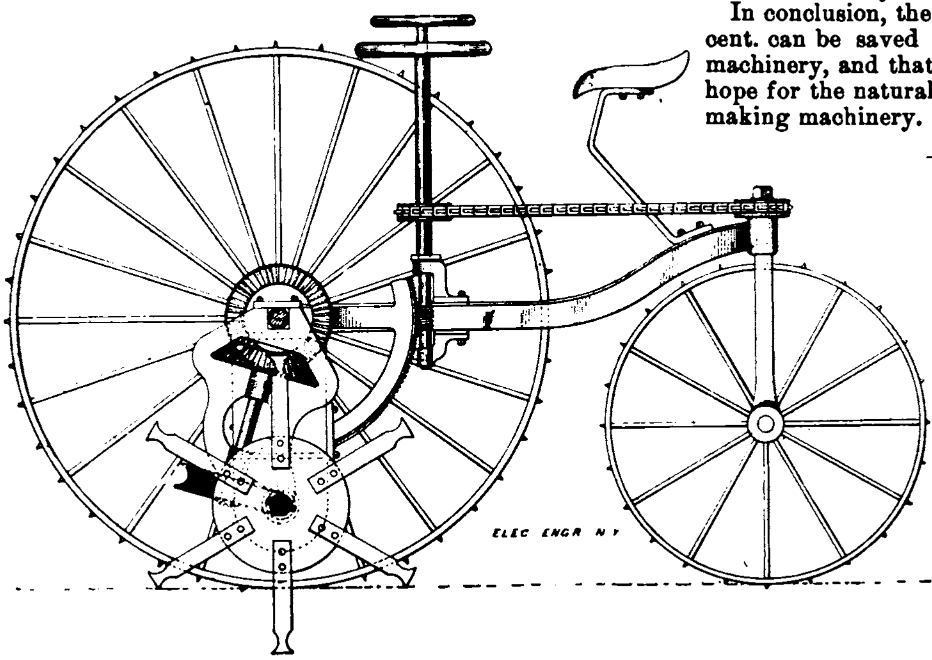


Fig. 1.—Kinsman Electric Ice Harvester.

With this cutter it is possible to groove ordinary ice almost through to the water, as the machine produces no shock or jar upon the ice, and its width and length is sufficient to give it the advantage of a broad bearing surface, while the weight of a No. 2 machine does not exceed that of a fair-sized horse; a No. 4 machine, carrying a gang of four cutters is somewhat heavier but not enough as to prevent cutting very thin ice with it.

The great change secured by the use of electricity in ice cutting is that the apparatus weighs comparatively little, and that the current can be generated at a merely nominal cost by the same power that lifts the ice into the house; while the same engineer who now attends to the lifting apparatus also cares for the generator. It will therefore be seen that the entire cost of grooving ice on the field is reduced to the wages of a man who rides the machine and a few extra pounds of coal used in the furnace, and that the entire force can be concentrated upon the housing of the ice, thus admitting of a full crop, which would otherwise be prevented by a sudden change of weather. As stated, the total weight of a No. 2 machine, with a capacity equal to from fifteen to twenty horses does not exceed that of a fair-sized horse, but, unlike the horse, requires absolutely no attention when not in use. It does not take cold when standing still, nor is it a total loss if it accidentally goes overboard.

As to the method of transmitting the current to the motor on the machine, two methods are available. Use can be made either of a trolley wire supported on sliding stands, or the cutter can be supplied with a reel. In either case no difficulty would be experienced.

In conclusion, the writer believes that from 30 to 50 per cent. can be saved by the use of electric ice-harvesting machinery, and that this method stands to-day as the only hope for the natural ice men against improved modern ice-making machinery.

LENGTH OF ELECTRIC WAVES.

M. Poincaré has announced to the French Académie des Sciences that M. Blondlot has measured by a new method the length of waves of electric oscillations, and that he has found that this length is proportional to the square root of the capacity, and to that of the self-induction, as required by Sir Wm. Thomson's formula. The mean of his experiments has given for the speed of propagation of electric waves in a metallic wire a figure not greatly different from the speed of light—a difference less than can be accounted for by errors of observation. The result is confirmatory of Maxwell's theory that light is due to alternate currents of very short periodicity.

AN ELECTRIC ROAD AT NIAGARA FALLS.

A corps of engineers on the Canadian side are now mapping out the line of an electric road between Chippewa and Queenston. The route through Victoria Park will be located just under the bank, along the western boundary of the reservation. It is likely that the power for this road may be obtained from the Niagara River, and a much bigger scheme is on foot for a power canal cutting across from the river and emptying down the Queenston Heights below the whirlpool.

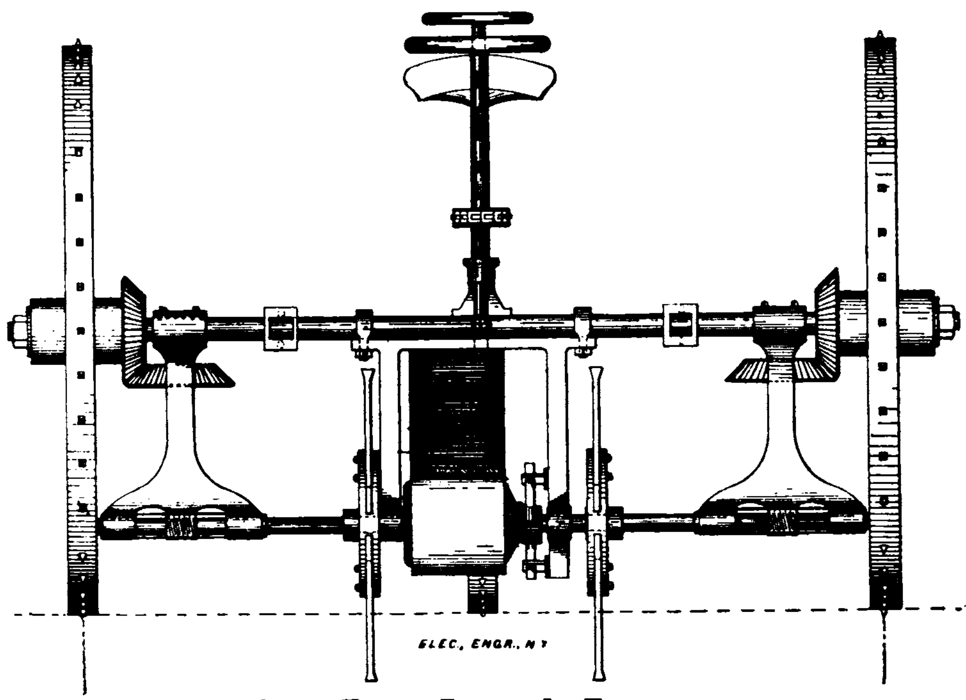


Fig. 2.—Kinsman Electric Ice Harvester.

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VOL. XII. NEW YORK, DECEMBER 30, 1891. No. 191

As we do not pound on a piano with all our strength to get a sound, but select different keys, so by using those components of light which we require, we may avoid wasting the other parts of the spectrum.—Prof. J. B. de Motte.

AGRICULTURAL ELECTRICAL ENGINEERING.

WE have from time to time printed notes on experiments which had been made looking to the influence of electricity on the growth of plants. These experiments may be divided into two classes; first, those involving the influence of the electric light directly upon vegetation; and, secondly, those in which the current was made to act directly upon the seed of the plant until its maturity. The experiments of Siemens some years ago and the more recent ones carried on in the Agricultural Department of Cornell University ought to show in some degree what can be expected by the first method, while the recent investigations by Specnew, in Russia, and others, give a fair indication of the value of the second method But electricity is capable of still further applications in agriculture in a direction which promises immediate results, and which cannot fail to secure for it the attention of agriculturists. The field still open to the electrical engineer is pointed out very forcibly by Mr. A. A. Denton, assistant in charge of the U. S. Department of Agriculture at Sterling, Kan., and consists in nothing less than the application of electric power to plowing. Mr. Denton points out that while we apply steam to the harvesting, threshing and transportation of grain, we are practically still pursuing the methods of thousands of years ago in the manipulation of the earth preparatory to the reception of the seed. As he puts it, while we can harvest and thresh 20 acres of grain per day, we can, by the method at present in vogue, in which animal power alone is employed, only plow up two acres a day. The problem to be solved, then, consists merely in providing a motor which shall be able to drag whatever appliance is necessary either for the tillage of the soil and the harvesting of the crop, in a straight line half a mile, reversing and dragging it back again until the entire field is worked. Mr. Denton considers the steam engine as unsuitable for this purpose and sees in the electric motor the ideal machine for this purpose. While the suggestion of the application of electric motors to the tilling of the soil was actually put in practice some 10 years ago in France, at Sermaize, it seems to have gone no further than the experimental stage. Mr. Denton's suggestion is, therefore, an eminently timely one and appears to involve no serious difficulties in its application. Nearly all the Western States have coal measures from which fuel can be drawn, so that the substitution of electric for animal power can be carried out with a large saving in time and cost. Many readers of THE ELECTRICAL ENGINEER will remember, too, that Mr. W. Forman Collins, of the staff of this paper, had an excellent article some months ago on the relation of electricity to the irrigation of the Western plains.

THE ARGUMENTS ON THE "HYDROCARBON" PATENTS.

THE argument of Mr. Christy, in behalf of the complainant in the recent trial of the suit of the United States Electric Lighting Co. against the Edison Lamp Co., involving the question of the validity of Weston's patent for the hydrocarbon treatment of incandescent lamp filaments, of which we give a full synopsis in another column, brings to a close the proceedings in this interesting and important case. In pursuance of a policy which has been consistently adhered to by the conductors of THE ELECTRICAL ENGINEER, that of placing upon record in its columns every matter of permanent interest affecting the leading electrical industries, no trouble or expense has been spared to present a full and adequate report of the arguments of counsel in each of the three great legal controversies, the final results of which must practically determine the ownership or control for some years to come, of the incandescent lamp manufacture of the United States. The first of these legal contests was the McKeesport case, so called, involving the Sawyer-Man patent for a fibrous carbon, and decided by Justice Bradley adversely to the patent; the second was the New York case, involving the Edison patent for the carbon filament, in which the patent was sustained by Justice Wallace; and the third is the New Jersey case recently tried in Philadelphia and now awaiting the decision of Justice Acheson, on Weston's hydrocarbon patent. Not only has no other journal attempted to give a report of the proceedings in these cases, but it may not be out of place to add that THE ELECTRICAL ENGINEER has received the highest commendation from eminent counsel engaged on both sides for the completeness, accuracy and impartiality of its reports of these trials. It is to the summary of the testimony of witnesses as given in the arguments of counsel, and to the opinions of the learned jurists with whom the ultimate decision of these controversies rests, that the future historian of the art of electric lighting must look for the greater part of his material, and this consideration must be our apology, if any be needed, for having devoted so large a space to matters which may seem to some of our readers of scarcely sufficient immediate interest to justify it.

ELECTRIC TRACTION FOR BROOKLYN.

A LONG fight at last is drawing to its close, and the great city of Brooklyn falls in line with the others that have already adopted electric traction. The common council has given permission to the Brooklyn City, Coney Island and Brooklyn, Brooklyn City and Newtown, and the Atlantic Avenue lines to change their motive power from horses to the overhead trolley system, and it is understood that Mayor Chapin will promptly approve the ordinance; while there is not the slightest reason to expect that the State Railroad Commissioners will change from their favorable attitude toward electric traction. This action by the Brooklyn city council means that about $12,000,000 will be spent there in the next two years in making the change, the Brooklyn City road spending alone at least half that amount.

The opposition to the change has been wild and absurd as usual, with the familiar stories of plague, nuisance and sudden death, and without a single fact in support of the allegations. The *Brooklyn Eagle* in an admirable editorial on the subject congratulates the citizens on the coming addition to the means of rapid transit, and points out that in like manner, though more vigorously, other boons were fought against in the City of Churches, such as the introduction of the water supply, the horse railroads, paid firemen, elevated roads, and uniformed police. All these things though bitterly opposed have come, and now everybody rejoices in their existence. So it will be with the trolley system. We are heartily glad to see that the street railway companies have made so successful a fight for themselves and for the public they serve.

ICE HARVESTING BY ELECTRICITY.

ON the preceding page we have referred to the adoption of the electric motor in agricultural operations, and the benefits which, it is shown, could be derived thereby. The arguments followed in that case are quite applicable to another case which, also, has thus far not received the attention that its importance would seem to merit. The methods pursued in ice harvesting have undergone no change in years, the horse being still the motive power employed. The manner in which the electric motor can be applied for the purpose and the saving in the cost of harvesting ice which can be effected by its use, furnish the subject of an interesting essay by Mr. F. E. Kinsman in this issue. As he points out, it permits not only of greater economy in the harvesting of thick ice, but it even permits of harvesting ice of such a thickness that it could not be attempted with horses; and thus admits of the profitable utilization of thin ice, which is now allowed to go to waste, although in mild winters it forms the only source of natural ice supply. It is not difficult to conceive, also, that a profitable business might be developed in the operation of portable ice-harvesting plants, so that the itinerant grain-threshing machine will find its counterpart in the traveling ice-harvesting machine.

THE SUCCESSFUL COMPETING TELEPHONE.

FOR several years subsequent to the invention of the Bell telephone and its successful application, a large percentage of the applications for patents filed in the Patent Office, in the Electrical Department, consisted of telephonic devices of one form or another, not a few of these relating to new forms of transmitters. Now that the transmitter in present use appears to be endowed with prolonged life by the recent issuance of the Berliner patent, we shall probably note a large increase in the number of telephonic inventions submitted to the Patent Office. Every intelligent inventor ought to know the state of the art in which he is seeking to effect improvement, and for those who have not followed the telephonic art with a view to its improvement, a résumé of the various methods of obtaining telephonic effects in an electric circuit will at this time prove of value. The admirable résumé of Mr. E. P. Thompson, on another page, shows that not a little ingenuity has been already expended in this direction. The experience of the past would seem to indicate that the demand for any invention has always been met when sufficient inducement has been offered to inventors, and in this case certainly the inducement is as great as that ever offered to an inventor. Mr. Thompson suggests a great many ways in which the goal may be reached.

"AMERICA'S GREATEST RAILROAD."

THE series of disastrous collisions which has accompanied the efforts of the management of "America's Greatest Railroad" to operate "the fastest and most perfect through train service in the world," provokes the very natural inquiry why it is, that on what is alleged to be "the only four-track railroad in the world," the passenger tracks should be incessantly blockaded by broken-down freight trains, and why in such case resort must necessarily be had to the archaic and futile expedient of sending a man back with a flag or lantern, who may go or may not, as may happen, and who may be seen or may not, as may happen, by the engineer of the approaching "flyer." The truth is, that two of the tracks of the "only" being one side of the North river and the other two the other side, it is somewhat difficult to separate effectually passenger and freight traffic; while the management seem to be as yet in a state of the most deplorable ignorance in respect to the utility, for signaling purposes, of an agent popularly known as electricity. We would by all means advise these ambitious people to take a course of elementary lessons in the modern art of conducting transportation, which might be done in the kindergarten department of the railway university at Altoona, or some other institution of the kind which is not hopelessly wedded to the outgrown traditions of the days of small things.

ISOLATED ELECTRIC LIGHTING BY LOW-TENSION ALTERNATING CURRENTS.

BY

William Smith Horry

It may seem curious to old-time electricians to hear any one seriously propose to revert to old and discarded methods of electric lighting and under a new name to flaunt them again before the public as something quite new and improved, yet this is precisely what is suggested in this paper. The development of the converter has totally changed the original "alternate current dynamo-electric machine" into the high-tension "alternator" of to-day which seems capable of anything—lighting, heating, welding, metal working, tempering, soldering or of twirling armatures hundreds of miles away. So, too, the development of the choking coil may lead us to revert to the original machine in all its simplicity, and to evolve, thereby, a more perfect method of isolated lighting than has ever existed before.

When the electric incandescent lamp was first invented it was said that the life it had was much increased by the use of the alternating current. I think this was conclusively proved at the time with such lamps as we had in 1880, though it does not apply so forcibly now, with the greatly improved vacuum and the hard and durable filaments such as are now made. Still the lamps *do* wear out slowly even now, the direct current attacking the ends of the horseshoe and the alternating wearing away the filament more evenly, but still surely, until it finally succumbs at the bend.

Electricians will remember, too, the alternating dynamo of 1880 of low tension and large quantity, and the installation of lamps in parallel or two or three in series. Before the days of compound winding for direct-current machines this system had its advantages in the steadiness of the electromotive force curve for all loads. All this is history now; we had no E. M. F. curves in those days. But this style of dynamo is gone. It was considered more expensive to construct than the newly discovered compound-wound, direct-current dynamo; it required too, a separate exciter and there was no advantage to compensate for the extra cost that such a machine entails. So it fell into disuse for several years until the converter was developed; then it assumed a new garb and new sphere of usefulness.

I propose to use again this style of machine connected, as of old, directly to the mains of the building to be lighted. The difficulties attending the installation of an alternating machine have been now overcome, and the dynamo of this pattern is now infinitely simple and little liable to derangement. Moreover, the commutator of the direct-current machine is generally in a neglected condition in isolated plants, and it soon wears out because the average attendant does not acquire the knack of keeping it in condition. In this new system the lamps are placed in parallel across the mains, and the Ries regulating socket is used. With this arrangement each lamp can be turned high or low just like gas, and the whole system then presents the appearance of being unique. The system is especially useful for the lighting of our large hotels which can now be fitted up from cellar to garret bedrooms, and all with absolute safety.

At present there is no electric light system that lends itself completely to this work. In the cities, gas is used in the bedrooms, and in the country, candles to help out the electric light plant downstairs. I have heard it stated by people ignorant of electricity that the electric light will not ascend above the first story. I am inclined to think the statement is correct of the several systems with which I am acquainted.

Extended experience with the Ries regulating socket has brought out very clearly the fact that there is great economy in systematically turning down the incandescent lamp when all its light is not required, although I am perfectly aware that theory conclusively proves the opposite to be true. There is economy in the life of the lamps themselves, and economy of power also; the lamp will last thousands of hours turned down this way, and still work out its 500 hours of good efficiency when turned on full. And then the current; the energy required to light up one corridor in a hotel would light up three or four well enough if the lamps were controllable and were adjusted to the requirements of the guests. If the light be wanted it is there; it indicates its own location and invites one to turn it on.

It is therefore contended that the low-tension alternator with the Ries regulating socket and lamps as described, introduce a combination which is an advance upon the usual practice of installing isolated plants, and that it will be found both on the score of economy and adaptability, greatly superior to any direct-current non-controllable system. It is, moreover, the only plan yet suggested for isolated lighting which is completely adapted to all the varied requirements of artificial illumination.

REACTIVE COILS IN PRACTICAL WORK.

BY

S. G. Neiler

In The Electrical Engineer of Dec. 9, under the title of "Reactive Coils," Mr. Otis K. Stuart explains the principle underlying the action of the coils, by giving a very clear explanation of what takes place in a transformer, but does not take up the reactive coil as it is used commercially. In reading over Mr. Stuart's article it struck me that it would not be amiss to go a step further and explain just how the current flowing in a circuit is controlled by the reactive coil and it is with that idea in view that I have written the following, hoping the same might be of some benefit to those not already familiar with the subject.

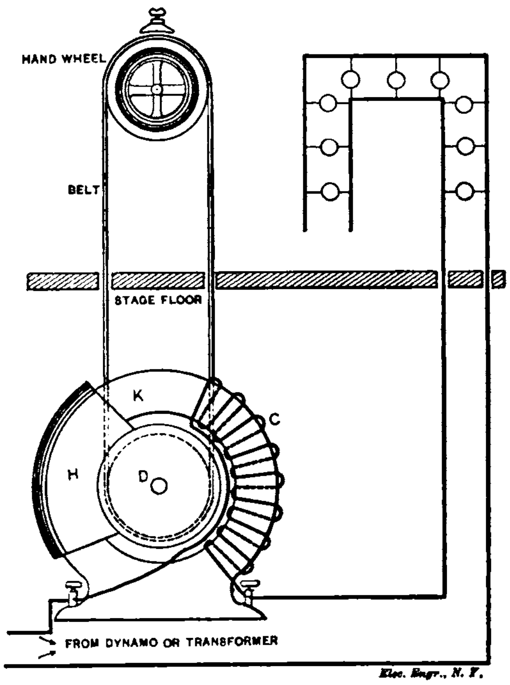
Mr. Stuart says: "A reactive coil placed directly in the circuit of an alternating system, therefore, can be made to control the amount of current going over the system. * * * Probably the most interesting application has recently been made use of by Mr. Elias E. Ries." He then gives a description of the socket, and says, "A very small reactive coil is so connected to a series of contacts that, by means of a movable arm * * * a relatively small or large amount of current may be admitted to the filament."

I think that one not familiar with the action of a reactive coil would be led to the conclusion that the only method of varying the strength of current would be by making a number of connections or "loops" into the coil and cutting out, or in, more turns which, of course, would accomplish the object, as exemplified in the Ries socket. But I think by far the most beautiful manner is that designed by Prof. Elihu Thomson and used by the Thomson-Houston Electric Company in their apparatus.

To explain clearly it will be necessary to understand that by placing a closed coil around an alternating magnetic field a current is induced in the coil forming the closed circuit, exactly similar to a transformer whose secondary is short-circuited. Now we may consider the action taking place in a Thomson-Houston reactive coil as illustrated in the accompanying diagram. This consists, primarily of a laminated iron core in the form of a closed ring K, about one part of which is wound a comparatively few turns of fine insulated wire C, covering about one-third of the circumference. Inside of this ring is a laminated iron drum D, fastened to which, and passing around the outer ring, is a copper hood H of large area, forming a closed coil about the ring and which fits closely, leaving a very small air space between it and the ring. This hood is fastened rigidly to the inner core and is provided with a handle or a pulley and belt so that it can be moved to occupy any position relatively to the winding on the ring.

When this hood is furthest away from the winding, the action is such as to increase the magnetizing effect of the coils by closing the magnetic circuit through the drum and hence to increase the number of lines flowing in the iron ring, so that the self-induction of the coil is very great and enough to nearly overcome the impressed electromotive force, thereby reducing the current flowing through the lamps.

By moving the hood so that it covers the winding, the current flowing in the hood would tend to counteract the magnetizing effect of the coils and by so doing lessen the self-induction of the same. When so placed, the relation



THE THOMSON REACTIVE COIL.

between the hood and the coils is the same as would exist in a transformer whose secondary was short-circuited and hence the coil offers but little resistance to the passage of the current. In any intermediate position of the hood the effect would be to increase, or decrease, the self-induction of the coil as the hood was moved further from, or nearer to, the winding.

The current used in the lamps is nearly in direct proportion to the brilliancy of the light; such being the case it is seen that in these reactive coils there is comparatively little loss of energy. The arrangement is such that when the hood completely envelops the winding, the coil is short-circuited, the hood completing the circuit across the terminals, and by so doing avoiding the loss due to the resistance of the coil and allowing the lamps to take their full amount of current. In the Ries socket the object is accomplished by cutting out sections of the winding and thereby reducing the self-induction in the wire and allowing a correspondingly greater current to flow.

The above, together with Mr. Stuart's article, will, I think, help to make the action of the reactive coil clear to those not already acquainted with the same. The illustration shows the arrangement employed for regulating the lights in theatres, the reactive coil being operated by a pulley and belt on the stage floor.

NOTE ON GALVANIZED IRON TELEGRAPH WIRE.

BY

Frederic A. C. Perrine

In the London *Electrician* for December 28, 1888, there was printed an article giving the results of tests, and the requirements of galvanized iron telegraph wire as used by the Postal Telegraph Department of Great Britain. In this article it is stated that two qualities of wire are used, one known as "high-resistance" wire and the other as "low-resistance" wire, the first giving a resistance at 60 degrees F. of 12.7 ohms per mile for a wire of the standard gauge, 171 mils, while the low resistance wire is either of "special blend" iron, 11.3 ohms per mile, or "charcoal" iron, having a resistance under the same conditions of 11.2 ohms per mile. This low-resistance wire is used for circuits exceeding 200 miles and the high-resistance for shorter lines. A tabulation of the qualities of these three grades of wire is also given, together with a mile-ohm comparison with pure iron.

According to this, the breaking strength of the "blend" iron is 3.2 times the weight per mile, of the "charcoal" 2.87 times the weight per mile, and the "high-resistance" 3.5 times the weight per mile; the two "low-resistance" wires give from 16 to 17 per cent. elongation in breaking, and the "high-resistance" 17 to 18 per cent. For a wire from 209 mils in diameter to one of 121 mils in diameter the number of twists in six inches varies in the "blend" iron from 17 to 30, and in the "high-resistance" from 22 to 38. The weight per mile-ohm of pure iron is given as 4,368.94 lbs., of the "blend" iron as 4,520, of the "charcoal as 4,480, and of the "high-resistance" as 5,080.

These are very interesting results, and in some respects remarkable, but the writer has not stated whether they are maximum or minimum figures, or whether they are averages of actual tests; neither does he seem to take into account the alteration in the mile-ohm of pure iron due to galvanizing it, since he says: "The relative resistances of pure copper and Swedish charcoal iron, similar to that used for the best line wire, are as 1 : 6.034; or the resistance of commercial iron is 6.034 times that of pure copper, not 6.558 times, as is usually given in text books. From this it appears that iron wire may now be obtained having a conductivity of 98.44 per cent. of pure iron."

Still, when he gives the mile-ohm weight of the best galvanized "blend" wire it has only the conductivity of 97.51 per cent. of that of pure iron, whereas the effect of galvanizing should be to reduce rather than to increase the weight of the mile-ohm.

In this country there is but one quality of wire at present in use for telegraph service in commercial lines, where a consistent series of tests is maintained. For short local lines and railroad private wires a great deal of steel and puddled iron is employed, but in these cases the only requirement is that it should stay on the poles and conduct. But our great telegraph companies employ for their commercial lines only the quality of iron which is known to the trade as "*Ex. B. B.*," a rather generic term, which is so interpreted by the specifications of the telegraph companies as to exclude all except the best grades of Swedish and Norway irons, which are imported in rolled rods and drawn, annealed and galvanized in this country.

Of this *Ex. B. B.* galvanized iron wire, about two years ago I had averages cast up from a long series of tests made on wire manufactured for the Western Union Telegraph Company, and found that the results varied with the size of the wire to a considerable extent; but that for any one size, the various tests were fairly concordant, and show that one wire is about 4 per cent. poorer in conductivity than the figures given on the English "blend" low-resistance wire, while the figures given on the "high-resistance" wire would not fill the specifications of our telegraph companies.

The exact averages on our wire are:

Date of test.	Size, B. W. G.	Quantity tested.	Resistance per mile.	Weight per mile.	Weight per mile-ohm.	Breaking weight.	Twists in 6 inches.	Elongation, per cent.
Feb., '88, to Jan., '89..	4	85 miles	6.51	716.7	4,664	3,016	18.5	13.83
Jan., '88, to Dec., '88..	6	650 "	8.55	544.96	4,663.5	1,454	18.9	13.82
Sept., '88, to Jan., '89..	8	3,500 "	12.18	379.8	4,629.5	980.5	21.4	15.16
Sept., '87, to Nov., '89..	9	8,300 "	14.008	331.9	4,620.5	877	24.3	14.21

The gradual decrease in the weight of the mile-ohm here to be observed is partially due to the greater proportionate amount of zinc on the smaller wires, though from the decreased elongation as well as the increased tensile strength of the heavier wires there seems to be an indication of more perfect annealing in the case of the smaller wire.

These tests upon a given number of miles are obtained by inspection of the wire in lots of from 50 to 100 miles, out of which are selected at random a certain number of coils,—about 10 per cent.,—from which test pieces are cut and carefully measured. These may, therefore, be taken as fair averages of the wire as it is produced for stringing on the poles in service. In experimenting with various grades of iron before finally selecting that which has been taken as the standard, remarkable results were obtained, and irons were found of much better quality, but, unfortunately, of which the price, when brought to this country, was prohibitory.

I have before me the result of a test of three samples made September 26, 1881, of which the weight per mile-ohm was 4,259.5. One of No. 12 galvanized wire manufactured by the Palmer Wire Company, tested March 31, 1884, giving a mile-ohm weight of 4,226.25, as well as quite a large number of samples giving better results than 4,350 pounds per mile-ohm. A number of tests have also been taken at various times on the same wire, both before and after galvanizing, and in every case there is a reduction in the weight of the mile-ohm by at least 5 per cent., due to the greater conductivity of the zinc.

While the results given above would indicate that in this country our telegraph companies do not use as high a grade of iron as the British Postal Department, yet I should judge from the method in which the English figures are given that our averages are fully as high as theirs, while in neither case is the highest obtainable grade of iron used.

HEYL ACCUMULATOR.

In the accumulator recently introduced by M. G. E. Heyl, the electrodes are composed of combinations of plumbic, chromic or tungstic acids with calcium, barium or strontium. To increase the coefficient of output and capacity, the inventor uses more particularly compounds of calcium and lead for the reason that these are easily oxidizable. The combination $CaPbO_4$ corresponding to 68 per cent. of peroxide of lead, contains 4.56 per cent. of active oxygen. The other alkaline earths, or of baryta, or strontium, furnish analogous compounds applicable to the purpose. Besides the advantage resulting from the chemical nature, the compound $CaPbO_4$ would offer a further valuable property in its porosity; it might replace the diaphragm employed to separate the elements of cells. The analogous compounds of chromium and tungsten can be employed in the same manner.

ELECTROMOTIVE FORCE, WITH SPECIAL REFERENCE TO THE EXTENSION OF OHM'S LAW.—II.

BY

Maurice Oudin, M.S.

The measurements of E. M. F. have in all cases been made in air. The result cannot with certainty be considered the true contact force. What is measured is not the Volta effect of zinc and copper, but zinc, air and copper, which may be something quite different. With the object of finding out what influence atmosphere had upon E. M. F., Von Zahn placed a pair of metallic plates in a vacuum. The E. M. F. of the two elements was considerably lower than that in air. The impossibility of obtaining a perfect vacuum prevents any conclusion from this test. For the E. M. F. depends not at all on the quantity of the active material present. Though only a few molecules of oxygen remained in the vessel, the effect would not be materially changed. Clerk Maxwell suggested measuring the E. M. F. of two substances by the Peltier effect. Speaking of the Volta force in the first volume of his classical work, he says: "The greater part must be sought for not at the junction of the two metals, but at one or both surfaces which separate the metals from the air or other medium which forms the third element in the circuit." Oliver Lodge, who is at the head of what we may call the modern school of electricians, agrees with Maxwell's views as far as they go. The contact-force not being sufficient, we have seen, to account for the whole E. M. F., the question naturally arises, where is the true source? Prof. Lodge locates it at the junction of the zinc and electrolyte. He regards the air as a dielectric bath of oxygen. Metals immersed in it are attacked by the oxygen molecules If they do not succeed in combining with the metal, the effort to do so, the chemical strain, as it were, produces certain physical effects. Oxygen being an electro-negative element, attacks the metals with different degrees of intensity. Hence the difference of potential. The medium, air, may be replaced by a fluid. In the case of a gas the dielectric is in a state of strain. If an electrolyte be the medium a current flows on connecting the metals.

It is well known that the entire heat developed in any battery is exactly equal to the heat that would be obtained by burning or consuming the elements of which the battery is composed, in some chemical capable of acting upon these elements. Accordingly the energy of such a battery bears a direct relation to the chemical changes taking place. It would naturally follow that such dependency should exist between the transfer of energy in the battery and the E. M. F. developed. This relation calculated from the heat of combustion of the elements composing various batteries has been found to exist in some cases. But up to the present, whether from errors in our data or the omission of some necessary constant, this dependency has not been found to be universally true.

There seems now to be no doubt about the presence of a true contact force at the junction of two metals. It is scarcely appreciable, being, under the best conditions, less than the E. M. F. of a single voltaic cell. It is dependent, apparently, upon the unequal vibration of the molecules of the dissimilar substances. There is an impingement and a constraint of molecules having different velocities. The molecules of one metal fail to accommodate themselves to the time of vibration of the opposing molecules, and a flow is set up in the direction of greatest impact.

The so-called thermo E. M. F. discovered by Seebeck is a variety of contact force, produced when the junctions of a circuit formed of different metals are brought to different temperatures.

It has been found that for the production of a contact-force, it is not essential that the circuit should consist of different metals. A lack of homogeneity in two conductors of the same metal also gives rise to an E. M. F. when one juncture is heated.

Frictional electricity, or electricity in equilibrium, is the manifestation of contact-force. The specific resistance of substances that are good generators of static electricity is well nigh infinitely great compared with that of metals. In metallic bodies the excitation is at once propagated throughout the entire mass. In non-conductors it remains at the surface of contact, which is increased by the rubbing, and there accumulates. Consequently, while in metals the true contact-force is almost inappreciable, in non-conductors the same force may become very great.

One of the earliest known electrical phenomena was the property that certain crystalline bodies possess of acquiring opposite states of electrification at opposite ends, when subject to a variation of temperature. Tourmaline displays this property in a marked degree. It retains its charge for a considerable time, and if suspended in the presence of electrified bodies, it behaves much as a needle in a magnetic field. Certain crystals also become charged with electricity when subject to a mechanical strain or deformation. Quartz crystals, from their size and purity, show strong electrification under such conditions.

Another source of E. M. F. is the action of light on selenium, that rare element generally found associated with sulphur. The cell is usually made of two metals coated with selenium. Mr. Fritts used brass and gold plates. W. Siemens found the E. M. F. set up in diffused day-light proportional to the intensity of light, while Von Uljamn, using platinum plates thin to transparency, found it proportional to the square root of the intensity of the light. As the generation of a current requires energy, the question arises, Whence does it come? It is generally conceded not to be due to thermal action. It is either a chemical change resulting from the action of light, or a direct conversion of light waves into electrical energy. There is good ground for giving the preference to the latter explanation.

An E. M. F. is set up when a thin cross-shaped metallic strip conveying a current is placed in an intense magnetic field. If the terminals of a sensitive galvanometer and of a battery be connected to opposite arms, and the strip be placed so that its plane is at right angles to the direction of the magnetic field, the presence of a current will be indicated by a slight deflection of the galvanometer needle. This is the Hall effect.

A year ago there appeared in the technical press, an article on the generation of a magneto-optical E. M. F. It is well known that a ray of polarized light traversing a magnetic field in a direction parallel to the lines of force, will have its plane of polarization twisted an amount depending on the strength of field. Conversely, if by any means a polarized beam of light can be made to oscillate it ought to generate an alternating E. M. F. Prof. Sheldon claims to have reached such a result. It was shown however, by Prof. Brackett, of Princeton, that the E. M. F. detected could not have been due to the ascribed cause. We might expect from the reversibility of most physical phenomena that some effect would be produced. However, as a scientific authority suggests, since polarized light passing through a solution of sugar has its plane rotated it would follow that if polarized light fell on one side of a glass beaker containing water and its plane be rotated, sugar might be expected to fall out at the other.

The various sources of E. M. F. that have been described above are capable of evoking a continuous current. In such circuits the galvanic constants are related according to Ohm's law. Now there is another order of phenomena, where Ohm's law fails to apply. It was found early in the history of telegraphy, that when the key of the transmitting instrument was opened and shut many times in a minute, the effect upon the receiving magnet at the other end of the line was much diminished. The current for some reason did not attain its maximum value during the make and break of the circuit. With a given number of cells and a line of known resistance, the current in practice was less than it ought to have been by Ohm's law. Evidently the element of time, which did not enter into Ohm's law, had to be considered. It was not long before it was proved that the retardation of the full value of the current and its diminution when the circuit was rapidly made and broken was due to the electromagnetic induction of the circuit on itself, or, as it is briefly called, self-induction. To understand the modification of Ohm's law through self-induction, we must study the nature of induction and how this quality of a circuit gives rise to a counter E M. F.

The phenomena of induction were discovered by Faraday in 1831. Oersted had 11 years previous observed how a current affected an adjacent compass, causing it to deflect from its position in the magnetic meridian. This proved as a fundamental fact the existence of a magnetic field surrounding a wire conveying a current. Faraday took up the line of experimental investigation at this point, and by a series of brilliant and remarkable experiments brought out all the facts of electromagnetic induction. He found that when a wire was moved in the vicinity of a magnet, or when a wire conveying a current was moved relatively to another wire, a temporary E. M. F. was set up. He found this to vary in strength with the velocity with which the wire was moved. The same result was obtained when the conductors remained stationary and the current in one was increased or diminished. Although the phenomena of induction are many and complex, they arrange themselves under the heads of electromagnetic, self and mutual induction. The E. M. F. due to electromagnetic induction constitutes Faraday's principal discovery. Its general conditions have been stated. The name is restricted to that E. M. F. induced by the movement of a conductor near a magnet, or a wire conveying a current.

Both Henry and Faraday were early and indefatigable workers in the field of induction, and it is not so very strange that they independently discovered magnetic and self-induction. Priority of discovery of self-induction is given to Henry. He observed that when the current in a long wire was interrupted, a spark of some brightness appeared at the break, showing an increase in the strength of the original current. This is the so-called extra current. Henry explained the phenomenon, and gave it its present name. It is well worth while to notice here the insight Henry had at that early day into phenomena that only recently have assumed importance. In 1832 he discovered the oscillatory character of the lightning flash and also the discharge of Leyden jars. Years later Sir Wm. Thomson proved the same mathematically.

To properly understand induction, and more particularly self-induction, we must remember that a current traversing a wire produces a commotion in the medium surrounding it. We know that if such a wire be made to pass through a surface on which are sprinkled iron filings, the filings will arrange themselves in concentric rings around the wire. The circles thus formed show the direction in which the force of the current acts. When a current is started, the lines of force spread out on all sides like the ring waves in a pool of water from a central point of disturbance. When the current is broken, the lines of force collapse and fall back upon the wire. By the general theory of induction the springing up or dying away of magnetic lines produces an instantaneous E. M. F., always in such a direction as to oppose the change in the current. Hence self-induction prevents the current from immediately arriving at its maximum value on making the circuit, and causes it to persist a while after the break. It would appear as if a current of electricity possessed a quantity of the nature of inertia. A fly-wheel absorbs energy in passing from a condition of rest to a definite velocity, and then gives it all up again as work in some form on slowing down. To maintain its velocity uniform, if we neglect friction, no work need be done upon it. The analogy can be applied to the case of a wire carrying a current. Starting a current implies work done in the medium which is derived from the electrical energy of the current. Stopping the current restores the energy to the system. No expenditure of work is required to maintain its magnetic field when the current has assumed a steady regime. Faraday called that condition of the medium produced by a current the electro-tonic state. He lacked sufficient mathematical training to deduce the ultimate consequences of his experiments; but he recognized that induction depends on a change in the medium, and that in this operation work is involved.

Mutual induction is the third division of the general phenomena of induction. As self-induction is the flux of magnetic force produced around a circuit by any change in itself, so mutual induction is the magnetic flow set up in a circuit by any change in the current of an adjacent circuit. It is then the number of lines of force linked in two circuits when one circuit contains a varying current.

The current resulting from inductive E. M. F., or influenced by it, such as at the make or break of a circuit, or during any variable period, cannot, as we have seen, be calculated from Ohm's law. It is invariably less than it would be if it obeyed that law. The element of time has to be considered, that is, the delay in the current behind the E. M. F., and further, that any variation of the current implies work which, according to the sense of the change, is taken from, or added to, the energy of the current. The law of Ohm has to be modified to meet these cases by the introduction into the expression of a factor whose value depends on the conditions of the circuit and on the time. We apply this factor to Ohm's formula. It is then no longer a simple expression, but Ohm's law extended, or as Dr. J. A. Fleming calls it, when the factor becomes complex and troublesome "Ohm's law glorified." In circuits in which there exists a varying E. M. F., we have in place of Ohm's law, Helmholtz's well-known equation:

$$i = \frac{E}{R}\left((l - e - \frac{t}{T} \right)$$

In words this equation means that the current at any instant is equal to the current which would flow if there was no self-induction, less a quantity depending on the induction and resistance of the circuit, and also on the time from the instant when the circuit was made. A final solution of this equation when the E. M. F. varies periodically is:

$$i = \frac{E}{\sqrt{R^2 + p^2 l^2}} (\sin p\, t - \theta)$$

where p is 2π times the frequency of the current, and θ an angle, whose tangent is the ratio of $p\, L$ to R. To account for the diminution of the current in the variable state, the factor introduced into Ohm's law may be regarded as diminishing the impressed E. M. F. as in Helmholtz's expression, or as increasing the resistance in some way, as in the second equation. In practice the last form is more convenient, and we have in the denomination of the mathematical expression of Ohm's law thus modified a quantity to which the name impedance has been given, composed of the ordinary Ohmic resistance and a term inductive in character called the inductive resistance. As Helmholtz's equation shows an induction E. M. F. acts in opposition to the impressed E. M. F. As work is involved we might expect this result from conservation of energy. Such an opposing reaction is a counter E. M. F. Hence any work done in a circuit, such as electrolytic action, heating or cooling a junction, or moving a magnet, is a counter E. M. F., since it gives rise to an E. M. F. that opposes the original.

It follows that Ohm's law must be modified not only when there exists an induction E. M. F., but also when there is interposed in the circuit a counter E. M. F. due to any cause.

Whatever be the nature of the current, we find that the expression for its value, no matter how complex, retains the general features of Ohm's law. In all cases it may be resolved into two factors, one representing the value the current would have were the instantaneous conditions to continue—Ohm's law pure and simple—the other dependent upon the conditions under which the changes are taking place, and properly considered as modifying the first.

ON POLYPHASAL GENERATORS.—II.[1]

BY M. I. PUPIN, PH. D., COLUMBIA COLLEGE.

Consider now n iron ring cores of exactly the same dimensions and made of the same material. Let ρ be the reluctance of each ring. Let each of the n coils be interlinked with one of the iron rings; we shall have n homogeneous magnetic circuits, and as long as the magnetization of these rings is considerably below the saturation point we shall have

$$\frac{4\pi\, s\, c_1{}^1}{\rho} + \frac{4\pi\, s\, c_2{}^1}{\rho} + \ldots\ldots\ldots\ldots + \frac{4\pi\, s\, c^1{}_n}{\rho} = 0$$

That is to say, the magnetic induction in the n magnetic circuits obeys the same law as the n electric currents; we can therefore employ the method of polyphasal connection for the magnetic circuits also and we obtain what the Germans call a Verkettung der Magnetischen Ströme, which may be translated into English by a more accurate expression: Polyphasal *coupling* of magnetic circuits. A transformer constructed on this principle may be called a *coupled transformer.*

A simple consideration will show that the field rotates around the axis of the ring B synchronously with the rotation in the generator which produces the impressed E. M. forces. Consider the armature of the generator. Since the ampere turns on one side of the neutral plane are always equal and opposite in sign to the ampere turns on the other side of this plane it is evident that the magnetic field due to the ampere turns in the armature is fixed in space and perfectly symmetrical with respect to the plane of symmetry PP[1]. We can therefore say that this field, though *fixed in space, rotates with respect to the armature* with the *same angular* velocity with which the armature rotates in space. The distribution of the ampere turns over the stationary ring B being at any moment the same as that over the armature ring, it follows that the magnetic field of B also rotates with respect to B synchronously with the rotation in the armature. An inspection of the diagram in Fig. 4 will show that when the rotation in the generator is reversed the rotation of the field B will also be reversed.

The strength of the rotating magnetic field will vary in strength because the strength of the two equal magneto-motive forces which are working in multiple arc will vary. The following simple consideration will show us the law of this variation. Two cases must be considered separately. First, when n is an odd number; secondly, when n is an even number.

Case 1.

A simple definition will save me the tedious repetitions of long sentences. I define the sum of all the electromotive forces generated in all the turns which are at any moment on the same side of the neutral plane of the generator as the resultant impressed E. M. F. at that moment. The magnetomotive force of the rotating field will evidently vary according to the same law as the resultant impressed E. M. F. To find the law of variation of the resultant impressed E. M. F., consider the armature of the generator when the angle θ of coil 1 is zero. To make the reasoning shorter, I make now the angular width of each coil equal to $\frac{2\pi}{n}$, so that the n coils completely cover the ring, which makes $\alpha = \frac{\pi}{n}$. If this angular width is smaller, then a simple consideration will show that the law of variation which I am about to deduce will be exactly the same. In the position just mentioned, the coils 1, 2, 3, ... $\frac{n-1}{2}$ will all be on the same side of the neutral plane, whereas coil $\frac{n+1}{2}$ will be just half on one side and half on the other side of this plane. There is no electromotive force generated in this coil. As the above-mentioned angle θ begins to increase from zero, coil $\frac{n+1}{2}$ begins to contribute to

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1. Read at the sixty-second meeting of the American Institute of Electrical Engineers, New York, December 16th, 1891.

the resultant impressed E. M. F., but this contribution is just counterbalanced by the loss due to the entrance of coil n into the opposite region of the neutral plane. The variation in the resultant impressed E. M. F. is therefore due solely to the change of position of the turns in the coils 1, 2, 3, ... $\frac{n+1}{2}$, or on one side and the corresponding turns on the other side of the neutral plane. This will be the case until coil $\frac{n-1}{2}$ has completely passed to one side of the neutral plane and coil n is just bisected by it. During this interval Θ has increased from zero to $\frac{1}{2}\frac{2\pi}{n} = \frac{\pi}{n}$. The value of the resultant impressed E. M. F. at any moment during this interval is easily found. Denote it by E, then

$$E = e_1 + e_2 + \ldots\ldots e_{\frac{n-1}{2}}$$

$$= K\left\{\sin\left(\theta + \frac{\pi}{n}\right) + \sin\left(\theta + \frac{\pi}{n} + \frac{2\pi}{n}\right) + \ldots\ldots + \sin\left\{\theta + \frac{\pi}{n} + \left(\frac{(n-1)}{2} - 1\right)\frac{2\pi}{n}\right\}\right\}$$

$$= K\left\{\sin\left(\theta + \frac{\pi}{n}\right) + \sin\left(\theta + \frac{\pi}{n} + \frac{2\pi}{n}\right) + \ldots\ldots + \sin\left\{\theta + \frac{\pi}{n} + \left(\frac{n-3}{2}\right)\frac{2\pi}{n}\right\}\right\}$$

$$= \left\{\frac{K_1 \sin\left(\theta + \frac{\pi}{n} + \frac{n-3}{4}\frac{2\pi}{n}\right)}{\sin\frac{\pi}{n}}\right\} = K_2 \sin\left(\frac{\pi}{2} + \theta - \frac{\pi}{2n}\right)$$

$$= K_2 \cos\left(\theta - \frac{\pi}{2n}\right)$$

It is evident that the resultant impressed E. M. F. E varies during the interval from $\theta = 0$ to $\theta = \frac{\pi}{n}$ just like $\cos\left(\theta - \frac{\pi}{2n}\right)$; that is to say it varies just like a simple harmonic. When $\theta = \frac{\pi}{2n}$, E reaches a maximum which is equal to K_2, it has a minimum both when $\theta = 0$ and when $\theta = \frac{\pi}{n}$; each of these minima equals $K_2 \cos\frac{\pi}{2n}$. The ratio of the minimum to the maximum value equals $\cos\frac{\pi}{2n}$. For a three-phase system this ratio is .866, and it diminishes very rapidly as n increases. It is evident that after θ has reached the value $\frac{\pi}{n}$ the armature is, as far as concerns the resultant impressed E. M. F. in exactly the same position as at the start when $\theta = 0$. We conclude therefore that E has $2n$ equal

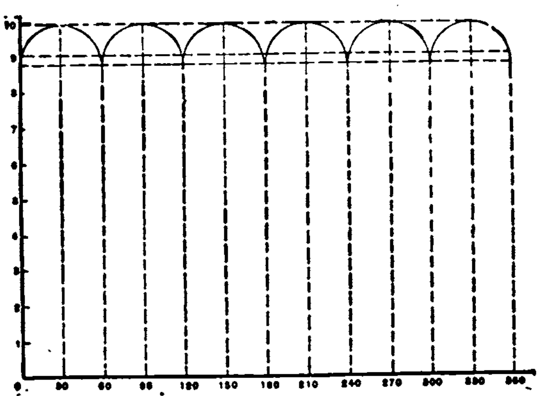


Fig. 5.

maxima and $2n$ equal minima during each revolution of the armature. In diagram Fig. 5 these fluctuations of E for a three-phase system are represented graphically.

CASE 2.

The same relations hold good when n is even. The maxima take place when $\theta = 0, \frac{2\pi}{n}, \frac{4\pi}{n}, \ldots\ldots$, The minima when $\theta = \frac{\pi}{n}, \frac{3\pi}{n}, \frac{5\pi}{n}, \ldots\ldots$ and the ratio of any minimum to any maximum is $\cos\frac{\pi}{n}$. Since the magneto-motive force varies according to the same law as the resultant impressed E. M. F., it follows that the strength of the rotary magnetic field fluctuates periodically, having $2n$ equal maxima and $2n$ equal minima during each revolution and the ratio of any minimum to any maximum equals $\cos\frac{\pi}{2n}$. That is, when n is odd, but when n is even then there are n maxima and n minima and the ratio of any minimum equals $\cos\frac{\pi}{n}$.

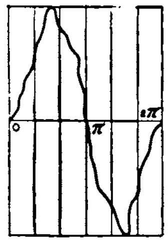


Fig. 6.

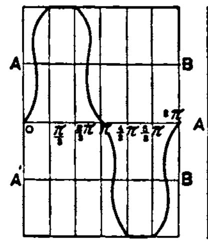


Fig. 7.

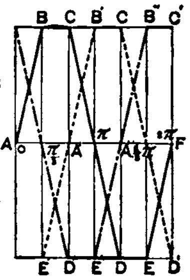


Fig. 8.

A polyphasal generator of this kind would produce a rotary magnetic field of constant strength only when $n = \infty$. For a three phase system the maximum variation would be nearly 14 per cent. of the maximum value. This agrees perfectly with Mr. Dobrowolsky's calculations, but I fail to see how these calculations could justify any one to assume that they hold good for all types of polyphasal generators[1]. The generator which we have considered could be actually constructed but its output would be so small in proportion to its size that we may dismiss it at once as an impracticable machine. We can make it practicable by substituting for the non-magnetizable ring which carries the armature coils a laminated iron ring and for the uniform magnetic field the magnetic field of a well made field magnet with its pole-pieces placed with respect to the armature coils in any one of the various ways sanctioned by practical experience. But in a generator of this kind the resultant impressed E. M. F. will no longer vary according to the law which I have pointed out a little while ago. To be sure, we shall still have the same number of maxima and minima, as may be inferred readily from our knowledge of the shape of the E. M. F. curve of a continuous current dynamo. We all know that this curve is not in general a straight line, but a wave line having as many maxima and as many minima as there are sections in the commutator. But the ratio of the maxima to the minima is no longer an a priori calculable quantity. If we knew the mathematical relation between the intensity of the field at any point of the armature surface and the co-ordinates of this point with respect to the neutral plane then we could calculate that ratio, but the amount of experimental and practical work involved in this problem would be very great. A much easier and practically much more important problem is to determine the conditions which must be fulfilled in the construction of a polyphasal generator, in order that it may be capable of producing a rotary magnetic field of constant intensity in the simplest possible way, that is, without the application of brushes and commutators. Mr. v. Dolivo-Dobrowolsky seems to think that the three-phasal generator is incapable of doing that, for he distinctly says that such a generator necessarily produces a rotary magnetic field whose strength varies 14 per cent. He also states that (evidently to obviate these fluctuations) the Allgemeine Elektricitaets Gesellschaft employ a method of transmitting currents of smaller differences of phase than one-third of the period through three wires. In this point they claim to be ahead of Tesla, Bradley, Haselwander and Wenstrom. In fact if one is not exceedingly careful in the perusal of Dobrowolsky's discussions of this subject he will be lead to believe that the rotary field in some of Tesla's motors varied as much as 40 per cent. and certainly not less than 14 per cent. I do not think that Mr. Dobrowolsky wishes to be understood as holding that opinion; for neither he nor anybody else excepting Tesla himself can know what these variations were. The number of phases employed tell us nothing definite about the range of these variations.

A polyphasal dynamo which is capable of producing a rotary magnetic field of constant intensity must be constructed in such a way that its resultant magneto-motive force must remain constant as long as speed and the magnetic field of the field magnets remain constant. As long as the variable electromotive force developed in each coil follows the law of a simple harmonic that result can never be accomplished by a finite number of phases,

1. M. v. Dolivo-Dobrowolsky: Der Drehstrom und seine Entwickelung; Officielle Austellungs Zeitung, Electricitaet, Heft 12.

but it may, perhaps, be accomplished by producing in each coil of the generator a variable electromotive force which varies according to some definite complex harmonic law. In a well-made commercial machine the electromotive forces developed in the various turns of the armature always vary according to some such a law. *The form of this complex harmonic law depends on the form of the magnetic field of the field magnets and also on the distribution of the coils over the armature.* The problem that remains to be investigated consists therefore of three parts: 1st. What must be the particular form of the complex harmonic E. M. F. developed in each coil of a polyphasal generator, in order that both the condition of continuity be fulfilled and also that the resultant impressed E. M. F. be continually constant. 2d. What form of the magnetic field of the field magnets will be capable of producing such an E. M. F. 3d. Can a continually constant resultant E. M. F. produce a rotary field of constant strength.

1st. The first part of this problem is purely mathematical. In a paper read before the New York Mathematical Society I indicated a method of discussing this part in a general way, and worked out completely two particular cases, namely, the cases of a three and four phasal system. The paper is given in the appendix.

2d. For a three-phasal system the form of the complex harmonic E. M. F. given in Fig. 7, will satisfy all the conditions. The form A, B, C, D, E, F, given in Fig. 8, is only a particular case and ought to be aimed at in the construction of the machine.

When there are only three turns within a space through which the armature moves with respect to the field during the time that corresponds to a complete period as in the case of the Lauffen generator (see Figs. 11 and 12), then the field of the field-magnets must be constant in intensity during an angle which corresponds to one-sixth of the period. I have indicated that in the diagram Fig. 9. In the case of bipolar three-phasal generators as indicated in the diagram Fig. 10, where we have six coils, the diametrically opposite pairs being connected in series, the pole faces must have an angular width of 120 degrees and the field must be constant in intensity within the region bounded at any moment by the armature and the pole faces. This is a practical problem offering no serious difficulties judging from the experimental results obtained by S. Thompson, Isenbeck, Mordey and others, and also from the experimental results obtained lately by a graduate of our school, Mr. Freedman, John Tyndall Fellow of Columbia College.

The curve of impressed E. M. F., which must be produced in the case of a four-phasal generator is given in Fig. 13, and needs no further commentary. Larger number of phases offer no special advantages whereas the disadvantages arising from employing a large number of phases are self-evident.

3d. When a coil in which a simple harmonic E. M. F. is developed is closed by a resistance, whether self-inductive or non-self-inductive, the current which is set up in the closed circuit will be a simple harmonic, having therefore all the characteristics of the impressed E. M. F. This, however, is not necessarily the case when the impressed E. M. F. is a complex harmonic. A complex harmonic E. M. F. is composed of a large number of simple harmonic E. M. forces of different frequencies, all the higher frequencies being multiples of the fundamental frequency. When, therefore, a coil in which a complex E. M. F. is generated, is closed by a conductor, and the current is started, the current will be also

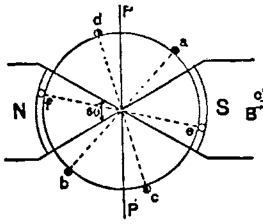


Fig. 9

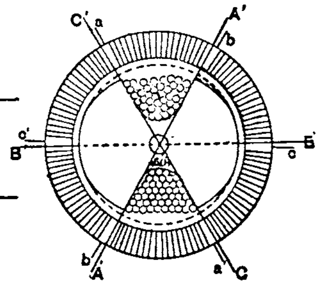


Fig. 10.

a complex harmonic, each simple harmonic component of the complex harmonic E. M. F. producing its own simple harmonic current which is a component of the resultant complex harmonic current. But since the component simple harmonic E. M. forces have each a different frequency, it follows that they will have a different impedance and the shifting of phase will be also different for each component current, currents of higher frequency having a larger shifting in phase and also the ratio of the amplitude of any one of the component currents to the amplitude of any other component of lower frequency, being smaller than the ratio of the amplitudes of the corresponding component E. M. forces. In this respect the propagation of the complex harmonic current-wave resembles very much the propagation of a complex harmonic sound-wave or a complex harmonic light-wave through an absorptive medium like air. The component simple harmonic waves of light and sound will in general suffer the less through the transmission, the longer their wave-length. Just as the sound and light-waves, after such a transmission, lose a great many characteristics of the original vibration which produced them, so an electric wave in its transmission through a conductor possessing ohmic resistance and electromagnetic, not to speak of the

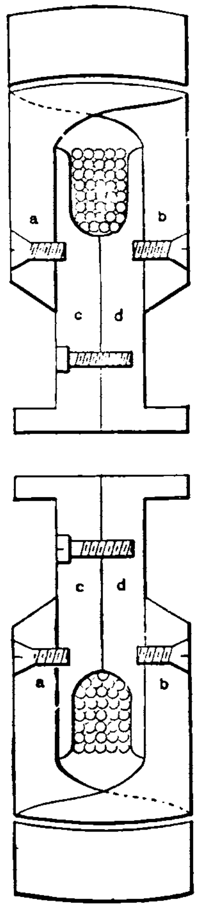


Fig. 11.

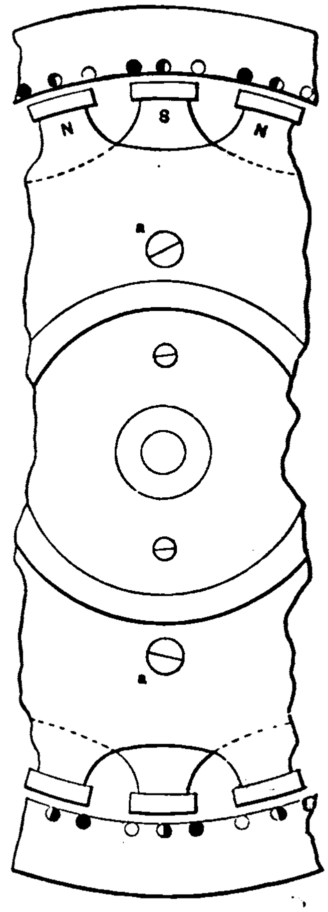


Fig. 12.

electrostatic, inductance will lose a great many characteristics of the impressed E. M. F.

To put this into simple symbolic language of mathematics,

Let L be the coefficient of self-induction of the circuit,
" R be the total resistance,
" $K \sum_{1}^{\infty}{}_m a_m \sin m\,p\,t$ be the complex harmonic impressed E. M. F. where $p = 2\,\pi \times$ fundamental frequency,
" x be the value of the current at any moment t.

We shall have, then,

$$L\frac{d\,x}{d\,t} + R\,x = K\sum_{1}^{\infty}{}_m\, a_m \sin m\,p\,t.$$

The solution of this differential equation gives

$$x = K\sum_{1}^{\infty}{}_m \frac{a_m}{\sqrt{R^2 + m^2\,p^2\,L^2}} \sin\,(m\,p\,t - \varphi_m)$$

$$\text{where } \tan\varphi_m = \frac{m\,p\,L}{R}$$

The current x is a complex harmonic, its component simple harmonic currents being

$$x = x_1 + x_2 + \ldots\ldots + x_m + \ldots\ldots \textit{ ad infin.}$$

$$\text{The current } x_\alpha = \frac{K\,a_\alpha}{\sqrt{R^2 + a^2\,p^2\,L^2}} \sin\,(a\,p\,t - \varphi_\alpha)$$

$$\tan\varphi_\alpha = \frac{a\,p\,L}{R}$$

Let E be the impressed E. M. F., then

$$E = e_1 + e_2 + e_3 + \ldots\ldots + e_m + \ldots\ldots \textit{ ad infin.}$$

The component simple harmonic E. M. F. e_α is given by

$$e_\alpha = a_\alpha \sin a\,p\,t$$

These relations give an exact quantitative expression to the preceding physical description.

These considerations made me hesitate at first in taking as granted that a polyphasal generator producing complex E. M. forces, such as I deduced mathematically in the course of my paper, would be capable of producing a rotary magnetic field of constant intensity. But I was glad to find out that my hesitation was groundless, at any rate in certain particular cases.

Consider the three-phasal generator whose diagram is given in Fig. 10. Take, now, another *well-laminated* armature wound in a similar way as the armature of the generator. Connect the three pairs of coils of the generator to the three sets of coils in armature 2. We shall have three separate circuits, the ohmic resistance and the self and mutual inductance in each circuit being the same. Denote by E_1 E_2 E_3 the three complex harmonic E. M. forces in the three circuits. Let x, y, z be the currents at any moment. Then we shall have

$$L\frac{d\,x}{d\,t}+M\frac{d\,y}{d\,t}+M\frac{d\,z}{d\,t}+R\,x=E_1,$$

$$L\frac{dy}{d\,t}+M\frac{d\,x}{d\,t}+M\frac{d\,z}{d\,t}+R\,y=E_2;$$

$$L\frac{d\,z}{d\,t}+M\frac{d\,x}{d\,t}+M\frac{d\,y}{d\,t}+R\,z=E_3.$$

But since $E_1+E_2+E_3=0$ for all values of t it follows that

$$L\,\frac{d}{dt}\,(x+y+z)+2\,M\,\frac{d}{dt}\,(x+y+z)+R\,(x+y+z)$$

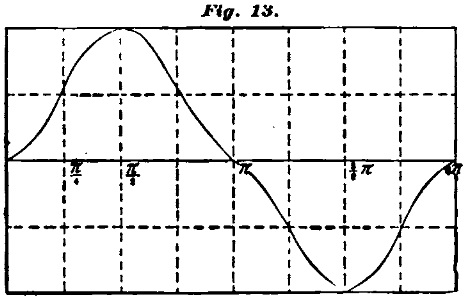
$= 0$ for all values of t. This can be true only if

$$x+y+z=0$$

for all values of t. That is to say, the currents fulfill the condition of continuity. We can therefore employ the method of polyphasal connection. Substitute now in the first of the three differential equations

$$z=-(x+y)$$

Fig. 13.



and we obtain

$$(L-M)\,\frac{d\,x}{d\,t}+R\,x=E_1=K\sum_1^{\infty}{}_m\;a_m\sin m\,p\,t$$

The solution of this equation gives

$$x=K\sum_1^{\infty}{}_m\frac{a_m}{\sqrt{R^2+m^2\,p^2\,(L-M)^2}}\sin\,(m\,p\,t-\varphi_m)$$

Similarly,

$$y=K\sum_1^{\infty}{}_m\frac{a_m}{\sqrt{R^2+m^2\,p^2\,(L-M)^2}}\sin\left\{m\,(p\,t+\frac{2\,\pi}{3})-\varphi_m\right\}$$

$$z=K\sum_1^{\infty}{}_m\frac{a_m}{\sqrt{R^2+m^2\,p^2\,(L-M)^2}}\sin\left\{m\,(p\,t+\frac{4\,\pi}{3})-\varphi_m\right\}$$

In the case under consideration both L and M are pretty small when the metallic parts of the magnetic circuits are near the saturation point, so that $L-M$ is exceedingly small, and $m^2\,p^2\,(L-M)^2$ will be very small in comparison to R^2 even for large values of m, unless the frequency is very high. Also, since

$$\tan\varphi_m=\frac{m\,p\,(L-M)}{R}$$

φ_m is exceedingly small unless p is very large, we shall have for moderate frequency generators

$$x=\frac{K}{R}\sum_1^{\infty}{}_m\,a_m\sin m\,p\,t$$

and similarly for y and z. The same method of reasoning may be easily applied to any number of phases. The mathematical operations will be considerably larger, but still the same results will be deduced without much difficulty.

That is to say, the curves for the currents are the same complex harmonics as those of the impressed E. M. F. The currents therefore produced a rotary magnetic field of nearly constant intensity; this is evidently true even if these currents produce a saturation in the iron part of the magnetic circuits.

The resemblance between a polyphasal generator and a continuous current dynamo, which these relations bring into view, is exceedingly striking and instructive.

The advantages gained from a polyphasal generator capable of producing a rotary magnetic field of constant intensity would be very much diminished indeed if it should turn out that it is impossible to devise a simple and efficient method of transformation[1] by means of which the polyphasal system of currents producing a rotary field of constant intensity (a constant rotary field system) can be transformed any number of times without losing its distinguishing characteristic. I intended to discuss this problem also this evening, but having been disappointed by the mechanician who is constructing several pieces of apparatus illustrating this problem, I decided to postpone this discussion to some other time.

To sum up:

1st. The consideration of simple harmonic impressed E. M. forces does tell the whole story of the polyphasal generators.

2nd. The law of variation of the strength of the rotary magnetic field which a polyhasal generator can produce is not as simple as Mr. v. D. Dobrowolsky thinks.

3rd. Polyphasal coupled transformers must be worked at *low magnetizations* and *low frequencies*, otherwise they will not satisfy the condition of continuity. It follows, therefore, that they will *probably be very large for the output which they can give.*

4th. It is very probable that nearly constant rotary magnetic fields can be produced in practice by a small number of phases (not more than three) by properly shaping the curve of the impressed E. M. F.

Letters to the Editor.

THE "JEWEL" INCANDESCENT LAMP TRADE-MARK.

In looking over the list of new incorporations, in a recent issue of the *Chicago Evening Post*, I noticed that certain parties, wholly unauthorized by me, have made application to the Secretary of State for the incorporation of a company for the manufacture of incandescent lamps, this company to be known as the "Jewel Incandescent Lamp Company."

The purpose of these parties, whoever they may be, is evidently to appropriate the name "Jewel" as applied to incandescent electric lamps; and for the purpose of defrauding me of my trade-mark, which I have extensively advertised and introduced, and which name has become very valuable.

The name or trade-mark "Jewel" as applied to incandescent lamps, originated with me, and is my personal property. Any attempts by other parties to pirate this name, is not only an injustice to me, but to users of the "Jewel" incandescent lamp.

By kindly giving this publication in your valuable paper, you will greatly oblige.

WM. HOOD.

CHICAGO Dec. 24, 1891.

A TELEPHONE TRANSMITTER WITH METAL SPRINGS.

In THE ELECTRICAL ENGINEER of Dec. 19th, a telephone transmitter without electrodes is illustrated and described.

In June, 1889, I constructed and operated transmitters based on this principle.

The springs used by me were metal; sometimes a round wire was employed; at other times a ribbon was coiled into a spiral and used.

Transmission was perfect, but not as loud as I hoped for. Carbon was suggested to me, but I had at that time no facilities for working it and abandoned it after repeatedly failing to construct a helix of it.

B. C. W.

ELMIRA, N. Y., Dec. 21, 1891.

MR. MACKAY AS SANTA CLAUS AGAIN.

A FEW days before Christmas Mr. J. W. Mackay, president of the Commercial Cable Company, instructed Vice-president Ward to pay to each and every employé of the company half a month's salary as a Christmas bonus to mark his appreciation of their cheerful and co-operative efforts during the year. He also sent the following cable to the boys: "I want the staff to aid me in keeping the 'Commercial' to the front. Let it always retain its reputation as the 'leading cable company—leading in accuracy, leading in speed, leading in staff.'

"I wish you and your families a Merry Christmas and a Happy New Year."

1. Not only transformation of the power supplied by the generator into electrical power of higher or lower potential, but also transformation of this power into mechanical power. This, of course, leads into the discussion of rotary fields produced under practical conditions.

Legal Notes.

INCANDESCENT LAMP LITIGATION—THE UNITED STATES ELECTRIC LIGHTING CO. vs. THE EDISON LAMP CO.—III.

ARGUMENT OF GEORGE H. CHRISTY FOR THE UNITED STATES COMPANY.

THE closing argument for the complainant was made by George H. Christy, Esq., of Pittsburgh. Mr. Christy said he would commence with a word in reference to the general equities of the case. He understood his brother Betts to allege that the invention in question had been given to the public; first by Sawyer and Man and second by Maxim, and that this had been done at a date such that Weston was barred from procuring a valid patent, and therefore stood in no position of equity in this court. Moreover, he thought his brother Betts clearly implied that his clients were entitled to the benefit of any equity asserted on behalf of Sawyer and Man or of Maxim, but in that opinion he apprehended that his brother had made a serious mistake as regarded the doctrine of equity. Assuming for the present that he was correct in what he had said of Sawyer and Man, it merely proved that they had made something known to the public in the assertion of an adverse right belonging to themselves. Could the public take anything by such a disclosure? or could this defendant take anything as a matter of equity? So also in the case of Maxim; the defendant was in no position to assert any equity as regards this invention. It did not claim under either of those parties. It could only assert an equity as part of the general public; but the general public could be entitled to no equity in view of anything that had been done by Sawyer and Man, or by Maxim, for what they had done had been under a claim of title and exclusive right of their own. Moreover, the party who was claiming this equitable right was the party charged with being the infringer, but an infringer (if it could be shown that defendants did infringe), was in no position to assert equities by virtue of anybody else's title.

The claim of complainant's patent was for "building up said core with carbon obtained and deposited upon the same by and during the operation of electrically heating said core." Mr. Christy showed by extracts from the specification that the term "building up" included any result whereby the carbon which was separated from the surrounding liquid, vapor or atmosphere, was put on, or into, or anywhere with reference to the conductor so as to impart to it the qualities desired for a burner for an incandescent lamp. His brother Betts had said that the words "for incandescent lamps" in the claim must be rejected as surplusage, or used as a term of limitation; if surplusage, then it was anticipated by Despretz; if, on the other hand, it was a limiting phrase, then the invention had not been complete until Weston had found out, by actually trying a treated carbon in a lamp, that it was suitable for that purpose. He (Mr. Christy), believed the latter meaning to be correct; but his brother Betts had been in error in his conclusion that the invention could not be completed until Weston had found out that it might be used as a commercial success in an incandescent lamp. That was not the standard of invention at all. The standard by which it was to be judged was this: Was the carbon pencil, thread, filament, stick, whatever it was, in better condition for that use after treatment than it was before? If so, the conditions of invention had been practically fulfilled, and it had been so because Weston had progressed far enough to ascertain that fact. Mr. Christy then read from Fontaine's book of 1877, a statement that the examination of incandescent carbons through a strongly colored glass had rendered their defects visible. That test was a part of the state of the art as it then existed. Would Mr. Weston then have had any difficulty, looking at his carbon, before and after treatment, through a smoked glass, to ascertain whether the carbon had been improved? And if he had found—as his testimony had said that he did—that such was the case, the invention had then, if he (Mr. Christy) correctly understood the law, been complete and perfect at that time. The testimony of Mr. Vandergrift was that the test of visual inspection was the one used to-day, and the only reliable one known in the art.

His brother Betts had contended that there had been no sufficient proof of infringement, and that the Weston process, so far as it had related to the use of oil, had never been commercially used. "Why,"—said Mr. Christy,—"his own client had used it." That use had been the very infringement complained of. He then read from the testimony of defendant's employees in confirmation of his statement, and said that it did not lie in the mouth of defendant to say anything about defects of a patent based upon the use of oil, or based on the use of red heat, for it had used both. Defendant had said there was no proof of sale or use. It was not necessary. Defendant was engaged in the business of manufacturing lamps; presumptively, when it had been proven to have made use of a process in its factory, by its workmen, and apparently in the ordinary course of business, it was fair to infer that it had been done for a purpose. Under the law the construction of a thing in a commercial way was a commercial use, but the proofs were that defendant's workmen had put the carbons into lamps. It seemed to him that that testimony made out a clear case of infringement. Defendant contends that it made but a few, but for present purposes the number made was immaterial. When complainant had made out a *prima facie* case, all that was necessary was to prove one act of infringement, and then in case the bill was sustained, to ascertain the extent of infringement.

But the testimony of defendant's employees had shown that the infringing had continued off an on at intervals for months; that carbons not in conformity with the standard had been treated, while those of the proper or desired resistance had not been treated. He would say here parenthetically, that he understood Mr. Edison claimed to have discovered a new material for a filament made from bamboo and to have invented a process for carbonizing his bamboo carbons so perfectly that they did not need this treatment. He then read from an affidavit of Mr. Edison in certain proceedings in Canada, introduced by stipulation into this case, setting forth at length the great difficulties attending the commercial process of carbonizing filaments. It was fair to infer, continued Mr. Christy, from what had been said by Mr. Edison and by his witnesses, that some carbons were made not good enough for use, and that to the extent of those carbons defendant had employed this process. Defendant had said that it had quit using the process, but it had not promised that it would not use it any more. His Honor was aware that a defendant could not take anything by such a pretension as that, unless it appeared that it had gone permanently out of the business and intended to stay out.

Again defendant had said that all that had been done had been experimental, but the testimony had shown that Mr. Holtzer, the superintendent of the works, had directed the electrician to continue the process as to all carbons not up to the standard. Yet defendant contended that the whole thing was an experiment; that they had only done a few, and that there was no proof that any of them ever went into a lamp that was sold.

Turning to another point, Mr. Clarke defendant's alleged expert—he said "alleged," because Mr. Clarke, had admitted that he had had no experience in the treatment of carbon—had been asked whether or not from the testimony of Broadbent and Quimby, a man skilled in the art as it existed in 1877 and 1878, could have manufactured a successful commercial lamp. That was not a correct standard by which to judge of that testimony. It had been taken simply as to certain facts within the knowledge of the witesses, and was not required by any rule of law or practice to be in the nature of a specification; hence the inquiry made of Mr. Clarke was immaterial and irrelevant. Again Clarke had said that Quimby did not say that Weston had told him he was going to put those carbons into electric lamps. It was not necessary to tell a painter that a picture represented a sunset nor to so label it. It was not necessary for Quimby to be told that the thing which he saw done in a glass globe had been intended for an incandescent lamp; he would have known that by seeing the experiment.

Defendants had said that Mr. Edison was entitled to the credit of the successful commercial lamp; that he had made it by getting rid of gases, and by the use of a vacuum, etc., but there were one or two very singular things in this case. His Honor would understand as complainant's view, that Weston was not bound to proceed with his application for a patent until a reasonable probability appeared that he could get some reward by the sale or use of a commercial lamp. So long as no commercial lamp was known in the art, in which his invention could have been used, he had done perfectly right in delaying his application and he had done it for good reasons. Defendants on that statement of facts, had been challenged to prove, if they could, that their inventor, Edison, or anybody else, had had a commercially successful lamp in such a way as to get some equity to it themselves as distinguished from Weston. If Mr. Edison had been the inventor that they claim, or if he had solved this problem in the fall of 1879, did it not seem probable that the fact would have been proven in this case? To whom had they gone for that credit? Not to Edison, but to Maxim; to the use made by him and the present complainant in November, 1880, and they had tried to bring themselves in as entitled to any benefit which might possibly have arisen in behalf of Mr. Maxim.

(*To be continued.*)

Appointments, Etc.

MR. B. L. FREEDY, who has been manager of the telephone exchange in St. Paul, has gone to Fargo, Dak., to assume management of the exchange there, while Mr. W. F. Burns, of Fargo, removes to St. Paul.

MR. ALEX. CHURCHWARD, the assistant electrician of the Riker Electric Motor Co. during the past year, has now been appointed general superintendent and electrician of that company.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED DECEMBER 22, 1891.

Alarms and Signals :—

Low-Water Alarm, F. St. Clair, 465,767. Filed April 11, 1891.
A steam low-water alarm, electrically actuated.

Train-Signaling Apparatus, P. Synnestvedt, 465,501. Filed Oct. 13, 1890.
An electric signal, by means of which the conductor of a railway train may readily communicate with the engineer.

Combined Signal and Telephone System, T. W. O'Brien, 465,648. Filed July 20, 1891.
Comprises an organization of electric circuits and appliances enabling a speaking instrument to be employed as a useful auxiliary to the ordinary system of arbitrary bell signals.

Electric Circuit Closer for Burglar Alarms, W. C. Thompson, 465,602. Filed Oct. 19, 1889.
A window sash burglar alarm.

Annunciator for the Supposed Dead, W. H. White, 465,548. Filed Nov. 24, 1890.

Clocks :—

Independent Electric Clock, W. J. Dudley, 465,655. Filed July 11, 1891.

Conductors, Conduits and Insulators :—

Conduit for Electric Wires, H. W. Jones, 465,564. Filed April 1, 1891.
Claim 1 follows:
A conduit for electric wires composed of strips of compacted asbestos fibre, wound in opposite directions, and waterproofing material, and cementing material.

Distribution :—

System of Electrical Distribution, F. A. La Roche, 465,594. Filed Oct. 9, 1890.
Has for its object the equalization of the difference of potential between the leads of an electric light or power circuit.

Means for Turning On and Off Electric Currents, T. C. Smith and B. D. Acker, 465,805. Filed Oct. 1, 1890.
A method of locally controlling an electric light circuit.

Dynamos and Motors :—

Dynamo-Electric Machine, R. Thury, 465,808. Filed Aug. 4, 1891.
A multipolar dynamo having two concentric rows of field magnets with the unlike poles of each series in juxtaposition, a rotatable armature compos-d of a divided hollow thin iron cylinder covered on the inner face with internal conductors and on the outer face with external conductors, and connections at the respective faces of the armature.

Lamps and Appurtenances :—

Globe-Holder for Electric-Arc Lamps, H. A. Foster, 465,470. Filed Nov. 3, 1890.
A clamping device for attaching globes to arc lamps.

Hanging Device for Arc Lamps, W. K. Howard, Jr., 465,665. Filed Oct. 30, 1890.
An automatic catch for arc lamps.

Electric Arc Lamp, H. C. Waldecker, 465,685. Filed Apr. 8, 1891.
Method of regulating the feed of arc lamp carbons by means of a piston loosely fitted into a tube containing liquid, which checks any sudden movement of the carbon.

Incandescent Electric Lamp Fixture, G. E. Villaret and V. E. Rondel, 465,-684. Filed May 23, 1891.

Electric Arc Lamp, H. P. Ball, 465,514. Filed June 13, 1891.
A cut-out for arc lamps, provided with a mechanical lock for holding the circuit closed.

Cut-Out for Incandescent Lamps, H. C. Wirt, 465,508. Filed Mar. 28, 1890.
An automatic short-circuting device for series incandescent lamps.

Measurement :—

Electrical Testing Instrument, R. Varley, Jr., 465,809. Filed Jan. 15, 1891.
A testing instrument for the purpose of locating very minute insulation faults in electric wires.

Metallurgical :—

Electrolytic Apparatus for Treating Metals, E. S. Hayden, 465,525. Filed Nov. 5, 1887.
Claim 1 follows:
In an electrolytic bath having a number of plates unconnected electrolytically excepting through a solution in the bath, and having narrow partitions extending from opposite sides of the bath adapted to hold the plates in a vertical position and out of contact with each other, and stops wholly between the partitions supporting the plates above the bottom of the bath.

Miscellaneous :—

Electric Switch, G. E. Painter, 465,618. Filed Apr. 16, 1891.
A small, compact, and inconspicuous switch for residences, etc.

Rheostat, W. S. Andrews and A. K. Warren, 465,512. Filed Aug. 26, 1891.
A rheostat for electric fan motors.

Electric Snap-Switch, W. S. Andrews, 465,511. Filed May 7, 1891.
A simple and inexpensive construction for the snap-switches.

Electric Switch, H. Barton, 465,444. Filed Dec. 15, 1890.
An electric switch in which, when the connections are made, the contact-piece is locked in position, and can only be released by pressure properly applied at the handle.

Railways and Appliances :—

Electric Railway Trolley, F. J. Sprague and P. O'Shaughnessy, 465,806. Filed Jan. 22, 1889.
A trolley employing a single horizontally-placed spiral spring, for the purpose of keeping an even pressure against the trolley wire.

Electric Railway, W. H. Applegate, 465,613. Filed Nov. 10, 1890.
A conduit railway in which a traveling conductor maintains electrical contact with the main lead without exposing the entire length thereof.

Gearing for Electric-Motor Cars, O. F. Evans, 465,593. Filed Jan. 24, 1891.
A worm-gear for use in connection with high-speed motors on electric cars.

Electric-Railwy Trolley, C. S. Foster, 465,469. Filed May 31, 1890.
A mechanism for securing the trolley on the trolley-wire so that it cannot become accidentally detached.

Guard for Trolley-Wire Insulators, F. O. Blackwell, 465,447. Filed May 29, 1891.
The guard for preventing the trolley from striking the insulator, when thrown from the wire.

Telephones and Apparatus :—

Adjustable Support for Telephones, C. H. Gatchell, 465,778. Filed Aug. 26 1891.
An adjustable bracket for telephone receivers.

Society and Club Notes.

THE THOMPSON SCIENTIFIC CLUB, LYNN, MASS.

At the regular meeting of the club the annual election of officers was held. The following were elected: President, J. B. Cahoon; 1st vice-president, H. G. Reist; 2d vice-president, F. C. Bates; secretary, F. Sheible; treasurer, J. B. Barr; librarian, E. D. Priest. Reviewers: Engineering, H. G. Reist; physics, H. S. Rodgers; natural science, J. E. Randall. Executive Committee: Messrs. Randall, Cahoon, Reist, Bates, Barr, Towner, Priest.

The rapid growth of the club is apparent when we consider that it was organized in May, 1889, and moved into its present extensive quarters last February. The reports of officers for the past year showed the club entirely out of debt, with quite a balance in the treasury. At present there are about 100 books and pamphlets in the library, together with 24 subscriptions to current scientific and popular periodicals, the latest addition being the *Century Dictionary*.

The club now numbers 134 members. At the last meeting Prof. Chas. R. Cross was elected an honorary member of the club.

The course of public scientific lectures now being held is in every way a success. The proceeds of this course will go towards fitting up the library of the club.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The subjoined resolution, passed by the international congress committee and the council of the American Institute of Electrical Engineers, is the outcome of the recent visit to New York city of Dr. Elisha Gray of Chicago, chairman of the Committee on the World's Electrical Congress.

Dr. Gray, after several informal interviews with officers and members of the institute, was invited to attend a meeting of the congress committee on December 16, where a mutual exchange of views upon the subject was had, and the result is entirely satisfactory to all parties interested.

Resolved, That the American Institute of Electrical Engineers, having already taken action during the past three years, by correspondence and otherwise, towards the holding of an International Electrical Congress in connection with the Columbian World's Fair, hereby expresses its desire and intention to co-operate, by all means in its power with the World's Congress Auxiliary of the World's Columbian Exposition, through its Electrical Congress Committee, in furthering the gathering of such a congress at Chicago in 1893, and in making it a successful and worthy representation of the best electrical science and practice in all parts of the world.

THE ELECTRIC CLUB.

On New Year's Eve (Thusday) Mr. Joseph Howard, the celebrated journalist and member of the club, will deliver a lecture at the club house entitled "A Plain Talk about Journalism." It may be counted upon as one of his most brilliant efforts, and will be heard by a large audience. The lecture will be followed by a high class musical programme.

THE NEW YORK ELECTRICAL SOCIETY.

At Columbia College, on Wednesday, Dec. 30, before the New York Electrical Society, Mr. A. A. Knudson will read a paper on 'Electrical Fakes." Such a subject is full of interest and amusement, and it will lose nothing at Mr. Knudson's hands.

THE MAGNETIC CLUB.

The annual meeting of the Magnetic Club of New York will be held January 14, at 195 Broadway, for the election of officers and four members of the governing committee.

DID NOT RECEIVE THE ITEM.

An electrical concern recently sent out some lamps with the note that the lamps shipped were "3.6 watts No. 3 base." The shipping list came back with the statement that the lamps had arrived but that the above item had not come to hand.

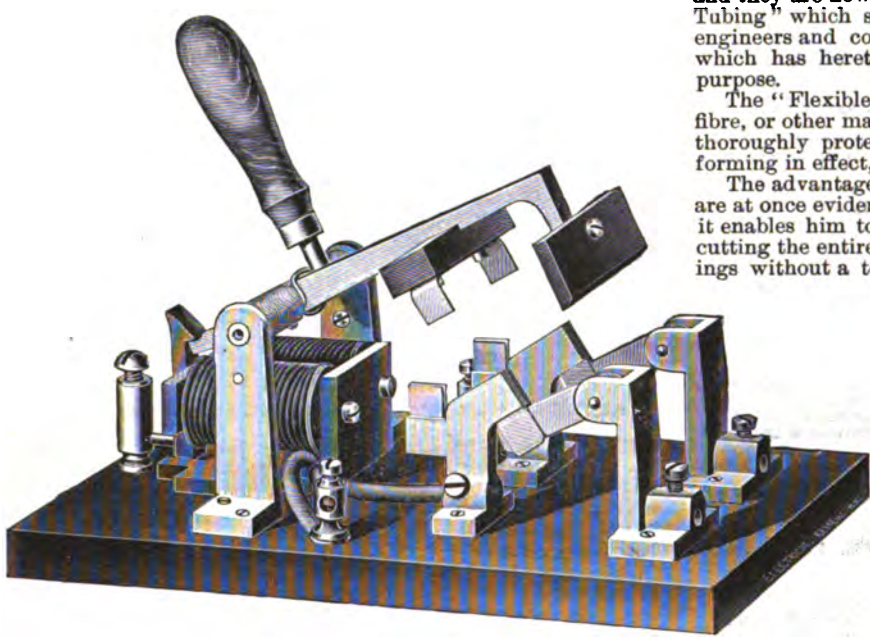
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The best way to get a happy and prosperous New Year is to advertise for it.

HILL'S SELF-ACTING SWITCH FOR CHARGING STORAGE BATTERIES.

THE switch shown in the above illustration was designed by Mr. W. S. Hill to be used when charging storage batteries from arc lighting circuits, to prevent the circuit from being opened and the streets being left in darkness, should any accident happen to the batteries, or any of the battery connections, by which the circuit would be broken.



HILL'S SELF-ACTING STORAGE BATTERY SWITCH.

The switch has four contacts, an electromagnet, and a lever actuated by a spring. When the lever is raised, as shown in the cut, the magnet, the four contacts and the batteries to be charged are all connected in series between the two binding posts. The latch that holds the lever up, is held by the pull of the magnet on an armature. Should anything occur to open the circuit for an instant, the magnet will be discharged and the latch be drawn back by a spring, releasing the lever, which will then drop and close the circuit between the two main line contacts, thus restor ing the circuit. At the same time the connection between the main and the battery contacts is broken, thereby disconnecting both ends of the battery circuit and preventing its being short-circuited on itself. With slight modification the same device is used to cut out the batteries when they have been sufficiently charged.

In this case the position of the magnet is reversed and it is made to release the latch, when a predetermined amount of current is passing through the magnet, the circuit through the magnet being connected to the terminals of the batteries, and in shunt thereto.

These switches are manufactured by the W. S. Hill Electric Co., of No. 54 Devonshire street, Boston, Mass., and are guaranteed to do all that is claimed for them in a satisfactory manner.

NOYE ENGINES FOR THE JAMESTOWN (N. Y.) ELECTRIC ROAD.

A NOTABLE addition will be made to the plant of the Jamestown Street Railway Co., Jamestown, N. Y., and the John T. Noye Mfg. Co., of Buffalo, N. Y., have secured the contract. There will be added two of the Noye Co.'s "B" style, heavy duty, compound condensing engines of about 400 horse power each, to operate two Short generators having a capacity of 250 horse power each, and it is expected that the enlarged plant will be in operation at the opening of the excursion season next spring. Provision has been made in the plant for another engine like the foregoing, which may be added later on. The present plant consists of three Dick & Church engines of 125 horse power each.

THE "FLEXIBLE CONDUIT."

MANY and various have been the devices for insulated tubing for the installation of electrical conductors in interiors, but, so far, all experiments seem to have been carried out on one line, that of a short, rigid tube, connected at intervals by joint sleeves or other similar devices and with rigid moulded bends, or elbows. Some of the devices, have been practically waterproof, some partially fireproof, and others in a measure flexible, but all have lacked one or the other of these highly necessary adjuncts.

It has remained for Mr. Charles H. Herrick, of Boston, Mass., to strike a happy combination of these three very important factors of a successful insulated tubing for interior wiring, and for the well-known American Circular Loom Co., of the same city, to carry out his ideas to a successful issue, in the manufacture of "The Flexible Conduit," which forms the subject of this article.

Their justly celebrated "Canvas Jacket" covering so successfully used by them in the manufacture of line wires, has enabled them to manufacture a strong, flexible, thoroughly waterproof cover, for the insulated flexible core, designed by Mr. Herrick, and they are now placing on the market, an insulated "Flexible Tubing" which seems destined to take the place, with electrical engineers and constructors, of much of the short, stiff tubing, which has heretofore been the only article obtainable for the purpose.

The "Flexible Conduit" is formed of a spiral lining of linen fibre, or other material, heavily taped with the best Para tape, and thoroughly protected and insulated by a heavy woven jacket, forming in effect, an insulated flexible hose.

The advantages of such a system of tubing for interior wiring, are at once evident to the practical electrical constructor, in that it enables him to install it in buildings already finished, without cutting the entire surface of the wall or ceiling and in new buildings without a tenth of the cost, as the "runs" can be made,

THE "FLEXIBLE CONDUIT."

owing to the long lengths of the "Flexible Tubing" without the use of joint sleeves.

The turns can also be made without the application of *elbows*, for the flexibility of the tube makes any curve, and even a complete circle of small diameter, possible. Being flexible, the tube will stand almost any amount of rough handling, making the waste generally arising from this source, practically nothing. The cost of joint sleeves and moulded elbows, is also done away with, as is the cost of the labor in the application of the same, which is really the prime factor in the expense of the conduit system of electrical wiring.

There is also an extended field for this manufacture, for the purpose of speaking tubes. It answers the purpose admirably, and is much cheaper and more lasting than anything now used for the purpose.

From the tests seen by the writer it is his opinion that the flexible tubing is thoroughly waterproof, highly non-inflammable, and thoroughly flexible, and there seems no reason why the field for the sale of it is not almost unlimited.

NEW YORK INSULATED WIRE CO.

IN ORDER to keep in closer touch with their business, which has so greatly developed during the last few years, the New York Insulated Wire Co. have decided to move down-town into the electrical district. They have now taken a suite of offices at 13, 15 and 17 Cortlandt street, Smith Building, on the third floor, and will enter upon occupancy January 1. The company will be duly represented there by Messrs. Gallaher, Godfrey and Olsen, and by Mr. Augustus Noll, its electrical engineer and expert. The company have also taken commodious storage on Warren street, and will there carry a very large stock of their celebrated wires and cables. They will thus be in excellent shape to handle the largest orders for "Grimshaw" white core wires, "Vulca" duct, and their street specialties. They report a very active business in "Vulca" duct, in Canada as well as in this country, and have a number of large buildings on their list for which Grimshaw has been specified.

WESTON ELECTRICAL MEASURING INSTRUMENTS AND APPLIANCES AT THE FRANKFORT ELECTRICAL EXHIBITION.

It may be remembered that the Weston Electrical Instrument Company, Newark, N. J., decided at the last moment to exhibit the Weston standard portable ammeters and voltmeters, and other electrical measuring instruments at the Frankfort Electrical Exhibition. In taking this course the company was well aware that its instruments would be subjected to close scrutiny by many of the most competent and eminent electricians and electrical engineers of Europe, and would be brought into direct competition with those made by such prominent firms as Siemens & Halske, Hartmann & Braun, and other makers of high-grade instruments. The Weston Electrical Instrument Company, however, felt great confidence in the merits of its goods, and was certain that if the instruments were thoroughly examined and tested, their great accuracy, permanency, portability and convenience would commend them to the favorable notice of the European electricians and engineers, and that it would be able to secure many orders for them.

Recent developments show that the confidence of the manufacturers in the merits of the Weston instruments was not too great. The company has received most favorable notice in many of the German scientific journals, and, what is more important, numerous orders for its voltmeters and ammeters from many of the best electrical engineering firms in Germany and other countries, including Siemens & Halske, Ganz & Co., Shuckert & Co., Lahmeyer & Co., Allgemeine Electricitats-Gesellschaft, the Societa Generale Italiana di Elettricita and the Brush Electrical Engineering Company. It has also received orders from many of the most distinguished electricians of Europe, notable among whom are Prof. H. F. Weber of Zurich, Prof. Kittler, Prof. Kohlrausch, Prof. Perret and Prof. Lichtheim. Prof. Weber was a member of the Testing Commission of the Frankfort Exhibition, and had an opportunity of thoroughly examining the merits of the Weston instruments.

We understand from the Weston Company that the instruments sent to Frankfort were not especially made for exhibition purposes, and that, as a matter of fact, were not equal to those sent out daily in the regular course of its business. Indeed, they were much inferior to the regular product, and would not have been passed for sale. This arose from the fact already stated, that the company did not decide to exhibit in Frankfort until about the time the Exhibition was to open and all the available space had by that time been taken by other exhibitors.

The Exhibition Committee, however, built an annex expressly for the company. The time required to prepare for so extensive an exhibit of the many varieties and ranges of its instruments, and the numerous parts entering into their construction, was necessarily very short. In addition to this, the Weston Company was greatly pressed with orders at the time, and was engaged in largely extending its facilities for manufacturing and standardizing the instruments. It was, therefore, extremely difficult to get out a sufficient number of the instruments to properly represent the work of the company. Under these circumstances it was impossible to spend the time necessary to secure close adjustment of the instruments intended for exhibition without greatly interfering with regular commercial work.

The Weston Electrical Instrument Company feel justified in expecting a still more favorable reception of its instruments after the filling of the numerous orders already received, arguing that, if the relatively poor ones sent as an exhibit were so favorably received, it is fair to suppose that those of its usual standard quality will be still more appreciated.

LARGE SALES OF PAGE BELTING.

The Page Belting Co., Concord, N. H., with stores in New York, Boston, Chicago and San Francisco, are moving on with their business in the usual manner, increasing in all departments and report that among the large belts which they have recently shipped is one to Richmond, one to Madison, Me., one to the Natick Electric Light Co., Natick, Mass.

Of their Acme link belts, among those shipped during the past month, have been the following:

A 15 inch belt to the Chattanooga Electric Railroad Co., Chattanooga, Tenn.; Pottstown Light, Heat and Power Co., Pottstown, Pa.; Shamokin Electric Street Railway Co., Shamokin, Pa.; Edison Electric Illuminating Co., Easton, Pa.; People's Street Railway Co., Scranton, Pa.; Huntingdon Electric Light Co., Huntingdon, Pa.

In their export business, they have shipped to Havana, Russia, Brazil and Caraccas. Of their Eureka dynamo belts, which are of double leather, slotted, they have shipped, among others, the following: Austin Water, Light and Power Co., Austin, Texas; Forest Mill Co., Clearfield, Me.; Xenia Electric Light Co., Xenia, Ohio; Danbury and Bethel Gas and Electric Light Co., Danbury, Ct., West End Street Car Co., San Antonio, Texas; Home Electric Light and Steam Heating Co., Tyrone, Pa.; Shamokin Street Railway Co., Shamokin, Pa.; Johnstown Electric Light Co., Johnstown, Pa.; Elmira Woolen Mills, Elmira, N. Y.

CROCKER-WHEELER CO. EXTENDING THEIR WORKS.

The large and increasing business done by the Crocker-Wheeler Electric Motor Company, New York, has several times made it necessary, during the year just closing, for them to secure more room for manufacturing purposes. The company report that they have again taken additional space in the buildings occupied by them at 430 and 432 West Fourteenth street, and will put in a lot of new machinery.

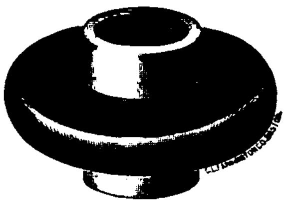
We note that the Augusta, Ga., *Chronicle* makes a very complimentary note on the Crocker-Wheeler exhibit at the local exposition, in care of Mr. George C. Field and Mr. W. E. Platt.

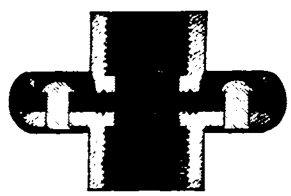
THE VIADUCT ELECTRIC CO.

The Viaduct Electric Co., of Baltimore, Md., has sent out as a seasonable souvenir a neat little box of lead pencils for its friends and customers. Each of the pencils is stamped with the name and compliments of the company.

THE McCARTHY INSULATED JOINT FOR ELECTRIC FIXTURES.

We illustrate this week a new form of insulated joint for use on electric and gas fixtures, manufactured by the W. T. C. Macallen Company, of 161 High Street, Boston, and the invention of Mr. Louis McCarthy, the manager of the company. Fig. 1





Figs. 1 and 2.—McCarthy Insulated Joint.

represents the joint as ready for use, and Fig. 2 is a section, showing in detail its construction. The joint consists of two halves of brass, with screwed ends for reception of gas pipe and fixtures insulated from each other by pressed mica washers. The flanges are riveted together, the rivet being in metallic contact with one flange and insulated from the other by mica. After the two flanges of the joints are thoroughly riveted together they are covered with a special insulating compound to prevent any danger of moisture on the outside forming a contact between the two halves. The use of pure mica sheet is new, is claimed to be entirely impervious to any acid or gas, and is, as is well known, perfectly fireproof. There are many well-known joints on the market, all more or less subject to the influence of gas tar or heat, and as this joint uses only pure mica, which is impervious to gas tar as an insulating material, and depends upon metallic parts for its strength, it is sure to at once become a favorite with electrical engineers. In appearance it is extremely neat, well finished and of first-class workmanship.

EUREKA TEMPERED COPPER.

The Eureka Tempered Copper Co., of North East, Pa., have got out a new circular entitled, "Long Stories Boiled Down to Suit Busy Men." It is full of pithy extracts from letters commendatory of their admirable specialty. These testimonials constitute a body of evidence that must carry conviction and lead to larger sales than ever.

THE BALL AND WOOD CO.

Those present at the station of the Edison Elec. Illg. Co., Patterson, on Dec. 19 witnessed a very pretty sight when the new compound engine of 250 h. p., built by the Ball & Wood Co., was started. Little Elizabeth Brock, four-year-old daughter of the general manager of the company, after some climbing, successfully reaching the throttle valve, and exerting all her strength gave it a twist which threw 2,500 more lights into the dark places of the city.

NEW YORK NOTES.

W. R. FLEMING & Co., 174 Fulton street, representing the Harrisburg Foundry and Machine Works, are installing the "Harrisburg" Ide and Ideal engines, as well as complete plants. The following are a few of the recent orders they have taken: For the H. W. Johns Mfg. Co.'s new factory, South Brooklyn, two 125 h. p. horizontal, steel single return-tubular boilers; Philip Daly's Pennsylvania Club House, West End, N. J., a complete plant of 60 h. p.; Dunellin Electric Light Co., Bound Brook, N. J., complete plant of 35 h. p.; Mr. Luther C. White, Waterbury, Conn., one 25 h. p. Ideal engine; Hotel "Marlborough," New York City, one 100 h. p. Ideal engine; Mr Jacob Rothchild, Fourteenth street, city, one 35 h. p. Ideal; Hotel "Endicott," Ninth avenue and Eighty-first street, two 100 h. p. Ideal engines. All of these contracts for engines were made with most rigid guarantees that the engines would run noiselessly and without vibrations. The firm are making a specialty of this class of work, appreciating how important it is that there should be no noise or vibration whatever in plants for hotel and apartment house service.

THE INTERNATIONAL ELECTRIC SUPPLY CO., through Mr. W. H. Fleming, E. E., the general manager of this company, Times Building, New York, has issued the following circular:—

This company has been organized to furnish at lowest market prices, every description of electrical apparatus and supplies required for arc and incandescent lighting, electric railways, electric plants for mining and power purposes, telegraph materials and telephones, house and hotel electrical supplies in foreign countries; more especially will its trade be devoted to the needs of our neighbors in Latin-America. The company is also in a position to furnish complete electric light installations, whether for central station work or isolated plants, for factories and plantations.

We understand that some large lighting contracts have already been closed for Mexico and Central America.

Mr. W. H. Fleming, the general manager of the new organization, is well known in this city, and from his extended practice in this country, as well as in the East and West Indies, in the installation of electric lighting stations, has gained an experience which will be of inestimable value in steering the company through the "quicksands" that others have fallen into in attempting to exploit and obtain the foreign electrical trade.

THE EASTON ELECTRIC COMPANY, Brooklyn, N. Y., has just installed another fifty-five arc light dynamo in the store of Wechsler & Abraham, on Fulton street, that city. This makes the fifth dynamo the Easton Company have sold to this well-known firm, and the order being given after eighteen months' trial of the other four dynamos, speaks well for the Easton system.

MR. J. L. SOMOFF, successor to the Union Electric Co., 1 Ann street, New York, has issued a neat four-page circular of his small incandescent lamps and appliances in connection with which they can be used. It gives full information as to sizes, prices, voltages, etc., and introduces some novel and useful designs to notice.

MR. F. NAPIER DENISON, of the Edison General Electric Company, Toronto, Can., leaves this week for an extended tour through the southern part of Europe and England, on account of ill health. He will combine business with pleasure and visit some of the principal electrical plants on the Continent.

NEW ENGLAND NOTES.

WHITMORE AND ROBINSON, of Boston, consulting electrical engineers, have issued another circular stating the object of their business. They have a well-appointed laboratory on Essex street, and are prepared to calibrate all kinds of instruments and test insulation, dynamos, motors, converters, fuses, primary or secondary batteries, etc. They make a speciality of testing iron and steel for induction, magnetic permeability or hysteresis properties, which are extremely important in the construction of dynamos, motors and converters. Whitmore and Robinson also act generally as consulting engineers and will aid purchasers in an intelligent purchase of electrical goods, charging for such work a percentage on the cost of the goods.

THE EVANS FRICTION CONE COMPANY, of Boston, are issuing their new catalogue for 1892, in which there are a number of new engravings showing some of their most recent applications of the Evans system to driving dynamos. For the larger sizes of dynamos the Evans Company are showing the application of extended bases with outboard bearings, in order to get a more perfect alignment and less vibration on the armature shaft, with a more perfect bearing between the fly-wheel of the engine or counter-shaft and the dynamo pulley. They also show the application of their system in driving four dynamos from one large upright engine, two dynamos being driven from each fly-wheel of the engine.

THE BEACON VACUUM PUMP AND ELECTRICAL COMPANY, of Boston, have made a decided success of their incandescent lamps, which are the only lamps in the market which are exhausted exclusively by means of a mechanical pump, and entirely without the aid of mercurial pumps, as used by other lamp companies. The Beacon pump is working to the entire satisfaction of the manufacturers and produces a vacuum in any quantity of lamps at the same time in a very few minutes, and is especially adapted for exhausting the larger sizes of incandescent lamps up to 150 candle-power. The Beacon pump is well worth the careful investigation of all incandescent lamp companies.

THE MATHER ELECTRIC COMPANY, of Manchester, Conn., have just published a very interesting little pamphlet descriptive of their new type of motor and power generator. The pamphlet contains a quantity of valuable information regarding the safe and economical working of motors and generators in general, and has some interesting diagrams showing the best methods of connecting up to the mains. It also contains valuable instructione upon starting and stopping motors and upon the necessary cars required for their successful and satisfactory working. The pamphlet is well worth reading and every engineer ought to procure one for his guidance in operating generators and motors.

THE AMERICAN ELECTRIC COMPANY, of Boston, proprietors of the New Era electric gas-lighting burner, have achieved quite a success. It is entirely different from anything on the market, the gas being lit by the mere turning of the gas-cock in the usual manner, without the intervention of any other piece of apparatus. The key of the gas-cock is thus always a true index of whether the gas is turned on or off, and thus prevents any possibility of accident by leaving unwittingly the gas turned on during the night. The American Company are full of orders and a very large business is anticipated.

THE W. S. HILL ELECTRIC COMPANY have made rapid strides since the organization of their company, and are now busy manufacturing small dynamos, motors and all kinds of electric switches. All the goods are made under the patents of Mr. W. S. Hill, who personally superintends their manufacture, while Mr. Poor attends to the general management of the company, and is succeeding in placing the company in a first-class condition to do a large business. The factory facilities have been doubled, and it looks as if more commodious quarters would soon be required.

THE JOHN BECKER MANUFACTURING CO., of Boston, makers of name plates, milling machines, etc., have moved to their new building, Water street, Fitchburg, Mass., where they will enjoy greatly increased facilities for their large business.

PHILADELPHIA NOTES.

MR. G. A. WILBUR, the Philadelphia agent for the Fort Wayne Electric Co., is rounding up the year with an excellent record. His latest installations are an additional plant for the Frankfort Avenue Merchants' Electric Light Co., consisting of four 60 Wood arc light dynamos; also an addition to each, the Southern Electric Light & Power Co. and the Allentown (Pa.) Electric Light & Power Co. of one 60 Wood arc light dynamo. The Edison Electric Illuminating Co., of Bellefonte, Pa., have also purchased a 40 Wood arc light dynamo.

MR. T. J. COPE, of the Cope Electric Pilot Line Co., has just returned from Washington, where he put about twenty miles of draw wires in the Lynch and Lake conduits of the Chesapeake & Potomac Telephone Co. successfully. There was some doubt expressed as to the ability of the machine to adhere to the vitrified surface of the terra cotta, but it ran full as well as in ducts of any other material, having run 450 feet in two minutes.

THE DIAMOND ELECTRIC LIGHT, HEAT & POWER CO., of Seventeenth and Somerset streets, whose plant was started some two weeks ago, are erecting poles and supplying arc and incandescent lights in the northern part of the city.

MR. BENJ. W. TINGLEY, secretary of the Heisler Electric Co., is just recovering from a severe attack of the grippe, this being his first sickness for over twenty years.

ST. LOUIS NOTES.

J. H. SIEGRIST, JR., & CO., St. Louis, just placed an "Ideal" engine in the new works of the Central Distillery Co., this city. They also sold this company one of the Bristol recording pressure gauges for making an accurate record of the pressure carried on their boilers.

WASHINGTON.—The Lynch and Lake terra cotta conduits lately reported favorably by the commission appointed by President Harrison, are giving entire satisfaction to the parties now wiring them in the District of Columbia, there being no breaks or unevenness to abrade the cables, which are easily drawn in.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.